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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XII. MIRACLES AND MEDICINE.

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PART II.

WE have seen that during the middle ages, while various churchmen, building better than they knew, did something to lay foundations for medical study, the Church authorities, as a rule, did even more to thwart it among the very men who, had they been allowed liberty, would have cultivated it to the highest advantage.

Then, too, we find cropping out everywhere the feeling that, since supernatural means are so abundant, there is something irreligious in seeking cure by natural means: ever and anon we have appeals to Scripture, and especially to the case of King Asa, who trusted to physicians rather than to the priests of Jahveh, and so died. Hence it was that St. Bernard declared that monks who took medicine were guilty of conduct unbecoming to religion. Even the School of Salerno was held in aversion by multitudes of strict churchmen, since it prescribed rules for diet, thereby indicating a belief that diseases arose from natural causes and not from the malice of the devil; moreover, in the medical schools Hippocrates was studied, and he had especially declared that demoniacal possession is "nowise more divine, nowise more infernal, than any other disease": hence it was, doubtless, that Pope Innocent III, about the beginning of the thirteenth century, forbade physicians, under pain of excommunication, to undertake medical treatment without calling in ecclesiastical advice.

Out of this feeling had grown up another practice, which made the development of medicine still more difficult—the classing of scientific men generally with sorcerers and magic-mongers: from this largely rose the charge of atheism against physicians, which ripened into a proverb, *Ubi sunt tres medici, ibi sunt duo athei.**

Magic was so common a charge that many physicians seemed to believe it themselves: in the tenth century Gerbert, afterward known as Pope Sylvester II, was at once suspected of sorcery when he showed a disposition to scientific methods; in the eleventh century this charge nearly cost the life of Constantine Africanus when he broke from the beaten path of medicine; in the thirteenth it gave Roger Bacon, one of the greatest benefactors of mankind, many years of imprisonment, and nearly brought him to the stake; these cases are typical of very many.

Still another charge against physicians who showed a talent for investigation was that of Mohammedanism and Averroism; and Petrarch stigmatized Averroists as "men who deny Genesis and bark at Christ." †

The effect of this wide-spread ecclesiastical opposition was, that for many centuries the study of medicine was confined mainly to the lowest order of practitioners. There was, indeed, one orthodox line of medical evolution during the later middle ages; St. Thomas Aquinas insisted that the forces of the body are independent of its physical organization, and that therefore these forces are to be studied by the scholastic philosophy and the theological method instead of by researches into the structure of the body; as a result of this, mingled with survivals of various pagan superstitions, we have in anatomy and physiology such doctrines as the increase and decrease of the brain with the phases of the moon, the ebb and flow of human vitality with the tides of the ocean, the use of the lungs to fan the heart, the function of the liver as the seat of love, and that of the spleen as the center of wit.

Closely connected with these methods of thought was the doctrine of signatures: it was reasoned that the Almighty must have set his sign upon the various means of curing disease which He has provided: hence it was held that bloodroot, on account of its red juice, is good for the blood; liverwort, having a leaf like the liver, cures diseases of the liver; eyebright, being marked with a spot like an eye, cures diseases of the eyes; celandine, having a yellow juice, cures jaundice; bugloss, resembling a snake's head,

* [Where there are three physicians there are two atheists.] See Daunou, cited by Buckle in the Posthumous Works, vol. ii, p. 580.

† See Renan, Averroès et l'Averroïsme, Paris, 1867, pp. 327–335. For a perfectly just statement of the only circumstances which can justify a charge of atheism, see Rev. Dr. Deems in Popular Science Monthly, February, 1876.

cures snake-bite; red flannel, looking like blood, is supposed to cure blood-taints, and therefore rheumatism; bear's grease, being taken from an animal thickly covered with hair, is recommended to persons fearing baldness.*

Still another injury was wrought by this theological pseudo-science. One of the ideas it evolved was that of disgusting the demon with the body which he tormented: hence the patient was made to swallow or apply to himself various unspeakable ordures, with such medicines as the livers of toads, the blood of frogs and rats, fibers of the hangman's rope, and ointment made from the body of gibbeted criminals. Many of these were survivals of heathen superstitions, but theologic reasoning wrought into them an orthodox significance. As an example of this mixture of heathen with Christian magic, we may cite the following from a mediæval medical book as a salve against "nocturnal goblin visitors": "Take hop plant, wormwood, bishopwort, lupine, ash-throat, henbane, harewort, viper's bugloss, heathberry plant, cropleek, garlic, grains of hedgerife, githrife, and fennel. Put these worts into a vessel, set them under the altar, sing over them nine masses, boil them in butter and sheep's grease, add much holy salt, strain through a cloth, throw the worts into running water. If any ill tempting occur to a man, or an elf, or goblin night visitors come, smear his body with this salve, and put it on his eyes, and cense him with incense, and sign him frequently with the sign of the cross. His condition will soon be better." †

As to surgery, this same amalgamation of theology with survivals of pagan beliefs continued to check the evolution of medical science down to the modern epoch. The nominal hostility of the Church to the shedding of blood withdrew, as we have seen, from surgical practice the great body of her educated men; hence surgery remained down to the fifteenth century a despised profession, its practice continued largely in the hands of charlatans, and down to a very recent period the name "barber-surgeon" was a survival of this. In such surgery, the application of various

* For a summary of the superstitions which arose under the theological doctrine of signatures, see Dr. Eccles's admirable little tract on the Evolution of Medical Science, p. 140. See also Scoffern, Science and Folk Lore, p. 76.

† For a list of unmentionable ordures used in Germany near the end of the seventeenth century, see Lammert, Volksmedizin und medizinischer Aberglaube in Bayern, Würzburg, 1869, p. 34, note. For the English prescription given, see Cockayne, Leechdoms, Wortcuring, and Starcraft of Early England, in the Master of the Rolls series, London, 1865, vol. ii, pp. 345 and following. Still another of these prescriptions given by Cockayne covers three or four octavo pages. For very full details of this sort of sacred pseudo-science in Germany, with accounts of survivals of it at the present time, see Wuttke, Prof. der Theologie in Halle, Der Deutsche Volksaberglaube der Gegenwart, Berlin, 1869, *passim*. For France, see Rambaud, pp. 371 *et seq.*

ordures relieved fractures; the touch of the hangman cured sprains; the breath of a donkey expelled poison; friction with a dead man's tooth cured toothache.*

The enormous development of miracles in the Church continued during century after century, and here probably lay the main causes of hostility between the Church on the one hand and the better sort of physicians on the other; namely, in the fact that the Church supposed herself in possession of something far better than scientific methods in medicine. Under the sway of this belief a natural and laudable veneration for the relics of Christian martyrs was developed more and more into pure fetichism.

Thus the water in which a single hair of a saint had been dipped was used as a purgative; water in which St. Remy's ring had been dipped cured fevers; wine in which the bones of a saint had been dipped cured lunacy; oil from a lamp burning before the tomb of St. Gall cured tumors; St. Valentine cured epilepsy; St. Christopher, throat diseases; St. Eutropius, dropsy; St. Ovid, deafness; St. Gervaise, rheumatism; St. Apollonia, toothache; St. Vitus, St. Anthony, and a multitude of other saints, the maladies which bear their names; even as late as 1784 we find certain authorities in Bavaria ordering that any one bitten by a mad dog should at once put up prayers at the shrine of St. Hubert, and not waste his time in any attempts at medical or surgical cure.† In the twelfth century we find a noted cure attempted by causing the invalid to drink water in which St. Bernard had washed his hands. Flowers which had rested on the tomb of a saint, when steeped in water, were supposed to be especially efficacious in various diseases. The pulpit everywhere dwelt with unction on the reality of fetich cures, and among the choice stories collected by Archbishop Jacques de Vitry for the use of preachers was one which, judging from its frequent recurrence in monkish literature, must have sunk deep into the popular mind: "Two lazy beggars, one blind the other lame, try to avoid the relics of St. Martin, borne about in procession, so that they may not be healed and lose their alms. The blind man takes the lame man on his shoulders to guide him, but they are caught in the crowd and healed against their will."‡

Very important also throughout the middle ages were the

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* On the low estate of surgery during the middle ages, see the histories of medicine already cited, and especially Kotelmann, Gesundheitspflege im Mittelalter, Hamburg, 1890, pp. 216 *et seq.*

† See Baas, p. 614; also Biedermann.

‡ For the efficacy of flowers, see the Bollandist Lives of the Saints, cited in Fort, p. 279; also pp. 457, 458. For the story of those unwillingly cured, see the Exempla of Jacques de Vitry, edited by Prof. T. F. Crane, of Cornell University; London, 1890, pp. 52 and 182.

medical virtues attributed to saliva. The use of this remedy had early Oriental sanction. It is clearly found in Egypt. Pliny devotes a considerable part of one of his chapters to it; Galen approved it; Vespasian, when he visited Alexandria, is said to have cured a blind man by applying saliva to his eyes; but the great example impressed most forcibly upon the mediæval mind was the use of it ascribed in the fourth Gospel to Jesus himself: thence it came not only into church ceremonial, but largely into medical practice.*

As the theological atmosphere thickened, nearly every country had its long list of saints, each with a special power over some one organ or disease. The clergy, having great influence over the medical schools, conscientiously mixed this fetich medicine with the beginnings of science: in the tenth century, even at the School of Salerno, we find that the sick were cured not only by medicine, but by the relics of St. Matthew and others.

Human nature, too, asserted itself then as now, by making various pious cures fashionable for a time and then allowing them to become unfashionable. Just as we see the relics of St. Cosmo and St. Damian in great vogue during the early middle ages, but out of fashion and without efficacy afterward, so we find in the thirteenth century that the bones of St. Louis having come into fashion wrought multitudes of cures, while in the fourteenth, having become unfashionable, they ceased to act, and gave place for a time to the relics of St. Roch of Montpellier and St. Catherine of Sienna, which in their turn wrought many cures until they too became out of date and yielded to other saints. Just so in modern times the healing miracles of La Salette have lost prestige in some measure, and those of Lourdes have come into fashion.†

Even such serious matters as fractures, calculus, and difficult parturition, in which modern science has achieved some of its greatest triumphs, were then dealt with by relics; and to this hour the *ex votos* hanging at such shrines as those of St. Geneviève at Paris, of St. Antony at Padua, of the Druid image at Chartres, of the Virgin at Einsiedeln, in the cave of Lourdes, nay, even at the fountain of La Salette, in spite of the fact that

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* As to the use of saliva in medicine, see Story, Castle of St. Angelo, and other essays, London, 1877, pp. 208, and elsewhere. For Pliny, Galen, and others, see the same, p. 211; see also the Book of Tobit, chap. xi, 2–13. For the case of Vespasian, see Suetonius, Life of Vespasian; also Tacitus, Historia, lib. iv, c. 81. For its use by St. Francis Xavier, see Coleridge, Life and Letters of St. Francis Xavier, London, 1872.

† For one of these lists of saints curing diseases, see Pettigrew, Medical Superstitions of the Middle Ages; for another, see Jacob, Superstitions Populaires, pp. 96–100; also Rydberg, p. 69; also Maury, Rambaud, and others. For a comparison of fashions in miracles with fashions in modern healing agents, see Littré, Médecine et Médecins, pp. 118, 136, and elsewhere; also Sprengel, vol. ii, p. 143.

thorough legal investigation has twice utterly disproved the miracle which gives sacredness to the place, are survivals of this same conception of disease and its cure.

So, too, with a multitude of sacred pools, streams, and spots of earth. In Ireland hardly a parish has not had one such sacred center; in England and Scotland there have been many; and as late as 1805 the eminent Dr. Milner, of the Roman Catholic Church, gave a careful and earnest account of a miraculous cure wrought at a sacred well in Flintshire. In all parts of Europe the pious resort to wells and springs continued long after the close of the middle ages, and has not entirely ceased to-day.

As to all these the argument was simply this: if the Almighty saw fit to raise the dead man who touched the bones of Elisha, why should He not restore to life the patient who touches at Cologne the bones of the Wise Men of the East who followed the star of the Nativity? If Naaman was cured by dipping himself in the waters of the Jordan, and so many others by going down into the Pool of Siloam, why should not men still be cured by bathing in pools which men equally holy with Elisha have consecrated? If one sick man was restored by touching the garments of St. Paul, why should not another sick man be restored by touching the seamless coat of Christ at Treves, or the winding-sheet of Christ at Bésançon? And out of all these inquiries came inevitably that question whose logical answer was especially injurious to the development of medical science: Why should men seek to build up scientific medicine and surgery, when relics, pilgrimages, and sacred observances, according to an overwhelming mass of concurrent testimony, have cured and are curing hosts of sick people in all parts of Europe? *

Still another development of the theological spirit, mixed with professional exclusiveness and mob prejudice, wrought untold injury. Even to those who had become so far emancipated from allegiance to fetich cures as to consult physicians, it was forbidden to consult those who, as a rule, were the best. From a very early period of European history the Jews had taken the lead in

* For sacred fountains in modern times, see Pettigrew, as above, p. 42; also, Dalyell, Darker Superstitions of Scotland, pp. 82 and following; also, Montalembert, Les Moines d'Occident, t. iii, p. 323, note. For those in Ireland, with many curious details, see S. C. Hall, Ireland, its Scenery and Character, London, 1841, vol. i, p. 282, and *passim*. For the case in Flintshire, see Authentic Documents relative to the Miraculous Cure of Winefrid White, of the Town of Wolverhampton, at Holywell, Flintshire, on the 28th of June, 1805, by John Milner, D. D., Vicar Apostolic, etc., London, 1805. For sacred wells in France, see Chevart, Histoire de Chartres, vol. i, pp. 84–89, and French local histories generally. For superstitions attaching to springs in Germany, see Wuttke, Volksaberglaube, §§ 12 and 356. For one of the most exquisitely wrought works of modern fiction, showing perfectly the recent evolution of miraculous powers in a fashionable spring in France, see Gustave Droz, Autour d'Une Source.

medicine; their share in founding the great Schools of Salerno and Montpellier we have already noted; and in all parts of Europe we find them acknowledged leaders in the healing art. The Church authorities, enforcing the spirit of the time, were especially severe against these benefactors: that men who openly rejected the means of salvation, and whose souls were undeniably lost, should heal the elect, seemed an insult to Providence; preaching friars denounced them from the pulpit, and the rulers in state and Church, while frequently secretly consulting them, openly proscribed them. Popes Eugene IV, Nicholas V, and Calixtus III especially forbade Christians to employ them. The Councils of Béziers and Alby in the thirteenth century, the Council of Avignon in the fourteenth, the Synod of Bamberg and the Bishop of Passau in the fifteenth, with many others, expressly forbade the faithful to call Jewish physicians or surgeons, under penalty of excommunication: such great preachers as John Geyler and John Herolt thundered from the pulpit against them and all who consulted them. As late as the middle of the seventeenth century, when the city council of Hall, in Würtemberg, gave some privileges to a Jewish physician "on account of his admirable experience and skill," the clergy of the city joined in a protest, declaring that "it were better to die with Christ than to be cured by a Jew doctor aided by the devil." Still, in their extremity, bishops, cardinals, kings, and even popes, insisted on calling in physicians of the hated race.*

Nor did the Reformation immediately change the sacred theory of medicine. Luther, as is well known, again and again ascribed his own disease to "devils' spells," declaring that "Satan produces all the maladies which afflict mankind, for he is the prince of death," and that "he poisons the air"; but that "no malady comes from God." From that day down to the faith cures of Boston, Old Orchard, and among the sect of "Peculiar People" in our own time, we see the results among Protestants

* For the general subject of the influence of theological ideas upon medicine, see Fort, History of Medical Economy during the Middle Ages, New York, 1883, chapters xiii and xviii; also Collin de Plancy, Dictionnaire des Reliques, *passim*; also Raimbaud, Histoire de la Civilisation en France, Paris, 1885, vol. i, chap. xviii; also Sprengel, vol. ii, p. 345, and elsewhere; also Baas and others. For the eminence of Jewish physicians, and proscription of them, see Beugnot, Les Juifs d'Occident, Paris, 1824, pp. 76–94; also Bédarride, Les Juifs en France, en Italie, et en Espagne, chapters v, viii, x, and xiii; also Rénouard, Histoire de la Médecine, Paris, 1846, tome i, p. 439; also, especially, Lammert, Volksmedizin, etc., in Bayern, p. 6, note. For denunciations of them by Geyler and others, see Kotelmann, Gesundheitspflege im Mittelalter, pp. 194, 195. For a list of kings and popes who persisted in having Jewish physicians, and for other curious information of the sort, see Prof. Levi de Vercelli, Cristiani ed Ebrei nel Medio Evo, pp. 200–207; and for a very valuable summary, see Lecky, History of Rationalism in Europe, vol. ii, pp. 265–271.

of seeking the cause of disease in Satanic influence and its cure in fetichism.

Yet Luther, with his sturdy common sense, broke away from one belief which has interfered with the evolution of medicine from the dawn of Christianity until now. When that troublesome declaimer, Carlstadt, declared that "whoso falls sick shall use no physic, but commit his case to God, praying that His will be done," Luther asked, "Do you eat when you are hungry?" and the answer being in the affirmative, he continued, "Even so you may use physic, which is God's gift just as meat and drink is, or whatever else we use for the preservation of life." *

But perhaps the best-known development of this theological view in the Protestant Church was that mainly evolved in England out of a French germ of theological thought—a belief in the efficacy of the royal touch in sundry diseases, especially epilepsy and scrofula, the latter being consequently known as the king's evil. This mode of cure began, so far as history throws light upon it, with Edward the Confessor in the eleventh century, and came down from reign to reign, passing from the Catholic saint to Protestant debauchees upon the English throne, with ever-increasing miraculous efficacy.

Testimony to the reality of these cures is overwhelming. As a simple matter of fact, there are no miracles of healing in the history of the human race more thoroughly attested than those wrought by the touch of Henry VIII, Elizabeth, the Stuarts, and especially by that chosen vessel, Charles II. Though Elizabeth could not bring herself fully to believe in the reality of these cures, Dr. Tooker, the Queen's chaplain, and later Dean of Lichfield, testifies fully of his own knowledge to the cures wrought by her, though he confesses that she was somewhat skeptical. William Clowes, the Queen's surgeon, also testifies fully to them. Fuller, in his Church History, gives an account of a Roman Catholic who was thus cured by the Queen's touch and converted to Protestantism. Similar testimony exists as to cures wrought by James I. Charles I also enjoyed the same power, in spite of the public declaration against its reality by Parliament. In one case the King saw a patient in the crowd, too far off to be touched, and simply said, "God bless thee and grant thee thy desire"; whereupon, it is asserted, the blotches and humors disappeared from the patient's body and appeared in the bottle of medicine which he held in his hand; at least so says Dr. John Nicholas, Warden of Winchester College, who declares this of his own knowledge to be every word of it true.

* For Luther's belief and his answer to Carlstadt, see his Table Talk, especially in Hazlitt's edition, pp. 250–257; also in his letters *passim*. For recent "faith cures," see Dr. Buckley's article on Faith Healing and Kindred Phenomena in The Century, 1886.

But the most incontrovertible evidence of this miraculous gift is found in the case of Charles II, the most thoroughly cynical debauchee who ever sat on the English throne before the advent of George IV. He touched nearly one hundred thousand persons, and the outlay for gold medals issued to the afflicted on these occasions rose in some years as high as ten thousand pounds. John Brown, surgeon in ordinary to his Majesty and to St. Thomas's Hospital, and author of many learned works on surgery and anatomy, published accounts of sixty cures due to the touch of this monarch; and Sergeant-Surgeon Wiseman devotes an entire book to proving the reality of these cures, saying, "I myself have been frequent witness to many hundreds of cures performed by his Majesty's touch alone without any assistance of chirurgery, and these many of them had tyred out the endeavours of able chirurgeons before they came thither." Yet it is especially instructive to note that while in no other reign were so many people touched for scrofula, and in none were so many cures vouched for, in no other reign did so many people die of that disease: the bills of mortality show this clearly, and the reason doubtless is the general substitution of supernatural for scientific means of cure. This is but one out of many examples showing the havoc which a scientific test always makes among miracles if men allow it to be applied.

To James II the same power continued; and if it be said, in the words of Lord Bacon, that "imagination is next of kin to miracle—a working faith," something else seems required to account for the testimony of Dr. Heylin to cures wrought by the royal touch upon babes in their mothers' arms. Myth-making and marvel-mongering were evidently at work here as in so many other places, and so great was the fame of these cures that we find, in the year before James was dethroned, a pauper at Portsmouth, New Hampshire, petitioning the General Assembly to enable him to make the voyage to England in order that he might be healed by the royal touch.

The change in the royal succession does not seem to have interfered with the miracle; for, though William III evidently regarded the whole thing as a superstition, and on one occasion is said to have touched a patient, saying to him, "God give you better health and more sense," Whiston assures us that this person was healed, notwithstanding William's incredulity.

As to Queen Anne, Dr. Daniel Turner, in his Art of Surgery, relates that several cases of scrofula which had been unsuccessfully treated by himself and Dr. Charles Bernard, sergeant-surgeon to her Majesty, yielded afterward to the efficacy of the Queen's touch. Naturally does Collier, in his Ecclesiastical History, say regarding these cases that to dispute them "is to come

to the extreme of skepticism, to deny our senses and be incredulous even to ridiculousness." Testimony to the reality of these cures is indeed overwhelming, and a multitude of most sober scholars, divines, and doctors of medicine declared the evidence absolutely convincing. That the Church of England accepted the doctrine of the royal touch is witnessed by the special service provided in the Prayer-Book of that period for occasions when the King exercised this gift. The ceremony was conducted with great solemnity and pomp; during the reading of the service and at the laying on of the King's hands, the attendant bishop or priest recited the words, "They shall lay their hands on the sick and they shall recover"; afterward came special prayers, the Epistle and Gospel, with the blessing, and finally his Majesty washed his royal hands in golden vessels which high noblemen held for him.

In France, too, the royal touch continued, with similar testimony to its efficacy. On a certain Easter Sunday, that pious king, Louis XIV, touched about sixteen hundred persons at Versailles.

This curative power was then acknowledged far and wide, by Catholics and Protestants alike, upon the Continent, in Great Britain, and in America; and it descended not only in spite of the transition of the English kings from Catholicism to Protestantism, but in spite of the transition from the legitimate sovereignty of the Stuarts to the illegitimate succession of the house of Orange. And yet, within a few years after the whole world held this belief it was dead; it had shriveled away in the increasing scientific light at the beginning of the eighteenth century.*

We may now take up more in detail the evolution of medical science out of the mediæval view and its modern survivals. All through the middle ages, as we have seen, some few laymen and ecclesiastics here and there, braving the edicts of the Church and popular superstition, persisted in medical study and practice; this was especially seen at the greater universities, which had become somewhat emancipated from ecclesiastical control. In the thirteenth century the University of Paris gave a strong impulse to the teaching of medicine, and in that and the following

* For the royal touch, see Becket, Free and Impartial Inquiry into the Antiquity and Efficacy of Touching for the King's Evil, 1722, cited in Pettigrew, p. 147, and elsewhere. Also, Scoffern, Science and Folk Lore, London, 1870, pp. 413 and following. Also, Adams, The Healing Art, London, 1887, vol. ii; and especially Lecky, History of European Morals, vol. i, chapter on the Conversion of Rome; also his History of England in the Eighteenth Century, vol. i, chap. i. For curious details regarding the mode of conducting the ceremony, see Evelyn's Diary; also, Lecky, as above. For the royal touch in France, and for a claim to its possession in feudal times by certain noble families, see Rambaud, Hist. de la Civ. Française, p. 375.

century we begin to find the first intelligible reports of medical cases since the coming in of Christianity.*

During the fifteenth and beginning of the sixteenth centuries the revival of learning, the invention of printing, and the great voyages of discovery gave a new impulse to thought, and in this medical science shared: the old theological way of thinking was greatly questioned, and gave place in many quarters to a different way of looking at the universe.

In the sixteenth century Paracelsus appears—a great genius, doing much to develop medicine beyond the reach of sacred and scholastic tradition, though still fettered by many superstitions. More and more, in spite of theological dogmas, came a renewal of anatomical studies by dissection of the human subject. The practice of the old Alexandrian School was thus resumed. Mundinus dared use the human subject occasionally in his lectures; but finally came a far greater champion of scientific truth, Andreas Vesalius, founder of the modern science of anatomy. The battle waged by this man is one of the glories of our race.

From the outset Vesalius proved himself a master. In the search for real knowledge he braved the most terrible dangers, and especially the charge of sacrilege, founded upon the teachings of the Church for ages. As we have seen, even such men in the early Church as Tertullian and St. Augustine held anatomy in abhorrence, and Pope Boniface VIII interdicted dissection as sacrilege, threatening excommunication against those practicing it. Through this sacred conventionalism Vesalius broke without fear; despite ecclesiastical censure and popular fury, he studied his science by the only method that could give useful results. No peril daunted him. To secure the material for his investigations, he haunted gibbets and charnel-houses, risking the fires of the Inquisition and the virus of the plague: first of all men he began to place the science of human anatomy on its solid, modern foundations—on careful examination and observation of the human body: this was his first great sin, and it was soon aggravated by one considered even greater.

Perhaps the most unfortunate thing that has ever been done for Christianity is the tying it to forms of science which are doomed and gradually sinking. Just as, in the time of Roger Bacon, excellent men devoted all their energies to binding Christianity to Aristotle—just as, in the time of Reuchlin and Erasmus, they insisted on binding Christianity to Thomas Aquinas—so, in the time of Vesalius, such men made every effort to link Christianity to Galen. The cry has been the same in all ages; it is the same which we hear in this age for curbing scientific studies; the

* For the promotion of medical science and practice, especially in the thirteenth century, by the universities, see Baas, pp. 222–224.

cry for what is called "sound learning." Whether standing for Aristotle against Bacon, or for Aquinas against Erasmus, or for Galen against Vesalius, or for making mechanical Greek verses instead of studying the handiwork of the Almighty, the cry is always for "sound learning": the idea always is that these studies are "*safe*."

At twenty-eight years of age Vesalius gave to the world his great work on human anatomy. With it ended the old and began the new: its researches, by their thoroughness, were a triumph of science; its illustrations, by their fidelity, were a triumph of art.

To shield himself, as far as possible, in the battle which he foresaw must come, Vesalius dedicated the work to the Emperor Charles V, and in his dedicatory preface he argues for his method, and against the parrot repetitions of the mediæval text-books; he also condemns the wretched anatomical preparations and specimens made by physicians who utterly refused to advance beyond the ancient master. The parrot-like repeaters of Galen gave battle at once. After the manner of their time their first missiles were epithets; and, the almost infinite magazine of these having been exhausted, they began to use sharper weapons—weapons theologic.

In this case there were especial reasons why the theological authorities felt called upon to intervene. First, there was the old idea prevailing in the Church, sanctioned by one at least of the popes, that the dissection of the human body is forbidden to Christians: this was used with great force against Vesalius; but he at first gained a temporary victory; for a conference of divines having been asked to decide whether dissection of the human body is sacrilege, gave a decision in the negative.

The reason was simple: the great Emperor Charles V had made Vesalius his physician and could not spare him; but, on the accession of Philip II to the throne of Spain and the Netherlands, the whole scene changed: the bigots were now sure to have their way.

Another theological idea barred his path. Throughout the middle ages it was believed that there exists in man a bone imponderable, incorruptible, incombustible, the necessary nucleus of the resurrection body. Belief in a resurrection of the physical body, despite St. Paul's Epistle to the Corinthians, had been incorporated into the formula made many centuries after his time and called the Apostles' Creed, and was held throughout Christendom, "always, everywhere, and by all." This hypothetical bone was therefore held in great veneration, and many anatomists sought to discover it; but Vesalius, revealing so much else, did not find it, and was therefore suspected of a want of proper faith. He contented himself with saying that he left the question re-

garding the existence of such a bone to the theologians. He could not lie, he did not wish to fight the Inquisition, and thus he fell under suspicion.

The strength of this theological point may be judged from the fact that no less eminent a surgeon than Riolan consulted the executioner to find out whether, when he burned a criminal, all the parts were consumed; and only then was the answer received which fatally undermined this superstition. Still, in 1689 we find it still lingering in France, creating an energetic opposition in the Church to dissection. Even as late as the eighteenth century, Bernouilli having shown that the living human body constantly undergoes a series of changes, so that all its particles are renewed in a given number of years, so much ill feeling was drawn upon him, especially from the theologians, who saw in this statement danger to the doctrine of the resurrection of the body, that for the sake of peace he struck out his argument on this subject from his collected works.*

Still other encroachments upon the theological view were made by the new school of anatomists, and especially by Vesalius. During the middle ages there had been developed various theological doctrines regarding the human body; these were based upon arguments showing what the body ought to be, and naturally, when anatomical science showed what it is, these doctrines fell. An example of such popular theological reasoning is seen in a wide-spread belief of the twelfth century, that during the year in which the cross of Christ was taken by Saladin, children, instead of having thirty or thirty-two teeth as before, had twenty or twenty-two. So, too, in Vesalius's time another doctrine of this sort was dominant: it had long been held that Eve, having been made by the Almighty from a rib taken out of Adam's side, there must be one rib fewer on one side of every man than on the other. It was also held upon the authority of Genesis that the Almighty created man literally out of the dust of the earth, and breathed life into his nostrils. This twofold creation was a favorite subject with illuminators of missals, and especially with those who illustrated Bibles and religious books in the first

* For the resurrection bone, see Desmazes, Supplices, Prisons et Graces en France, Paris, 1866, p. 162. For Vesalius, see especially Portal, Hist. de l'Anatomie et de la Chirurgie, Paris, 1770, tome i, p. 407. Also Henry Morley, in his Clement Marot, and other essays. For Bernouilli and his trouble with the theologians, see Wolf, Biographien zur Culturgeschichte der Schweiz, vol. ii, p. 95. How different Mundinus's practice of dissection was from that of Vesalius may be seen by Cuvier's careful statement that the entire number of dissections by the former was three; the usual statement is that there were but two. See Cuvier, Hist. des Sci. Nat., tome iii, p. 7; also Sprengel, Frédault, Hallam, and Littré; also Whewell, Hist. of the Inductive Sciences, vol. iii, p. 328; also, for a very full statement regarding the agency of Mundinus in the progress of anatomy, see Portal, vol. i, pp. 209–216.

years after the invention of printing; but Vesalius and the anatomists who followed him put an end among thoughtful men to this belief in the missing rib, and in doing this dealt a blow at much else in the sacred theory. Naturally, all these considerations brought the forces of ecclesiasticism against the innovators in anatomy.*

A new weapon was now forged: Vesalius was charged with dissecting a living man, and, either from direct persecution, as the great majority of authors assert, or from indirect influences, as the recent apologists for Philip II admit, he became a wanderer: on a pilgrimage to the Holy Land, apparently undertaken to atone for his sin, he was shipwrecked, and in the prime of his life and strength he was lost to the world.

And yet not lost. In this century the painter Hamann has again given him to us. By the magic of Hamann's pencil Vesalius again stands on earth, and we look once more into his cell. Its windows and doors, bolted and barred within, betoken the storm of bigotry which rages without; the crucifix, toward which he turns his eyes, symbolizes the spirit in which he labors; the corpse of the plague-stricken beneath his hand ceases to be repulsive; his very soul seems to send forth rays from the canvas, which strengthen us for the good fight in this age.†

He was hunted to death by men who conscientiously supposed that he was injuring religion: his poor, blind foes destroyed one of religion's greatest apostles. What was his influence on religion? He substituted, for the repetition of worn-out theories, a conscientious and reverent search into the works of the great Power giving life to the universe; he substituted for representations of the human structure—pitiful and unreal—representations revealing truths most helpful to the whole human race.‡

The death of this champion seems to have virtually ended the contest. Licenses to dissect soon began to be given by sundry popes to universities, and renewed at intervals of from three to four years, until the Reformation released science from this yoke.

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* As to the supposed change in the number of teeth, see the Gesta Philippi Augusti Francorum Regis, . . . descripta a magistro Rigordo, 1219, edited by Father Francis Duchesne, in Historiæ Francorum Scriptores, tom. v, Paris, 1649, p. 24. For representations of Adam created by the Almighty out of a pile of dust and of Eve created from a rib of Adam, see the earlier illustrations in the Nuremberg Chronicle.

† The original painting of Vesalius at work in his cell, by Hamann, is now at Cornell University.

‡ For a curious example of weapons drawn from Galen and used against Vesalius, see Lewes, Life of Goethe, p. 343, note. For proofs that I have not overestimated Vesalius, see Portal, *ubi supra*. Portal speaks of him as "*le génie le plus droit qu'eut l'Europe*"; and again, "*Vesale me paraît un des plus grands hommes qui ait existé.*" For the use of the charge that anatomists dissected living men—against men of science before Vesalius's time—see Littré's chapter on Anatomy.

I hasten now to one of the most singular struggles of medical science during modern times. Early in the last century Boyer presented inoculation as a preventive of small-pox in France, and thoughtful physicians in England, inspired by Lady Montagu and Maitland, followed his example. Ultra-conservatives in medicine took fright at once on both sides of the Channel, and theology was soon finding profound reasons against the new practice. The French theologians of the Sorbonne solemnly condemned it; the English theologians were most loudly represented by the Rev. Edward Massey, who in 1772 preached and published a sermon entitled The Dangerous and Sinful Practice of Inoculation. In this he declared that Job's distemper was probably confluent small-pox; that he had been inoculated doubtless by the devil; that diseases are sent by Providence for the punishment of sin; and that the proposed attempt to prevent them is "a diabolical operation." Not less vigorous was the sermon of the Rev. Mr. Delafaye, entitled "Inoculation an Indefensible Practice." This struggle went on for thirty years. Yet it is a pleasure to note some churchmen—and among them Madox, Bishop of Worcester—giving battle on the side of right reason; but as late as 1753 we have a noted rector at Canterbury denouncing inoculation from his pulpit in the primatial city, and many of his brethren following his example.

The same opposition was vigorous in Protestant Scotland. The great majority of ministers joined in denouncing the new practice as "flying in the face of Providence," and "endeavoring to baffle a divine judgment."

On our own side of the ocean, also, this question had to be fought out. About the year 1721 Dr. Zabdiel Boylston, a physician in Boston, made an experiment in inoculation, one of his first subjects being his own son. He at once encountered bitter hostility, so that the selectmen of the city forbade him to repeat the experiment. Foremost among his opponents was Dr. Douglas, a Scotch physician, supported by the medical profession and the newspapers. The violence of the opposing party knew no bounds; they insisted that inoculation was "poisoning," and they urged the authorities to try Dr. Boylston for murder. Having thus settled his case for this world, they proceeded to settle it for the next, insisting that "for a man to infect a family in the morning with small-pox and to pray to God in the evening against the disease is blasphemy"; that the small-pox is "a judgment of God on the sins of the people," and that "to avert it is but to provoke him more"; that inoculation is "an encroachment on the prerogatives of Jehovah, whose right it is to wound and smite." Among the mass of scriptural texts most remote from any possible bearing on the subject one was employed which was equally

cogent against any use of healing means in any disease—the words of Hosea: "He hath torn and he will heal us; he hath smitten and he will bind us up."

So bitter was this opposition that Dr. Boylston's life was in danger; it was considered unsafe for him to be out of his house in the evening; a lighted grenade was even thrown into the house of Cotton Mather, who had favored the new practice, and had sheltered another clergyman who had submitted himself to it.

To the honor of the Puritan clergy of New England, it should be said that many of them were Boylston's strongest supporters. Increase and Cotton Mather had been among the first to move in favor of inoculation, the latter having called Boylston's attention to it; and at the very crisis of affairs six of the leading clergymen of Boston threw their influence on Boylston's side and shared the obloquy brought upon him. Although the gainsayers were not slow to fling into the faces of the Mathers their action regarding witchcraft, arguing that their credulity in that matter argued credulity in this, they persevered, and among the many services rendered by the clergymen of New England to their country, this ought certainly to be remembered; for these men had to withstand, shoulder to shoulder with Boylston and Benjamin Franklin, the same weapons which were hurled at the supporters of inoculation in Europe—charges of "unfaithfulness to the revealed law of God."

The facts were soon very strong against the gainsayers: within a year or two after the first experiment nearly three hundred persons had been inoculated by Boylston in Boston and neighboring towns, and out of these only six had died; whereas, during the same period, out of nearly six thousand persons who had taken small-pox naturally, and had received only the usual medical treatment, nearly one thousand had died. Yet even here the gainsayers did not despair, and, when obliged to confess the success of inoculation, they simply fell back upon a new argument, and answered: "It was good that Satan should be dispossessed of his habitation which he had taken up in men in our Lord's day, but it was not lawful that the children of the Pharisees should cast him out by the help of Beelzebub. We must always have an eye to the matter of what we do as well as the result, if we intend to keep a good conscience toward God." But the facts were too strong; the new practice made its way in the New World as in the Old, though bitter opposition continued, and in no small degree on vague scriptural grounds, for more than twenty years longer.*

* For the general subject, see Sprengel, Histoire de la Médecine, vol. vi, pp. 39–80. For the opposition of the Paris Faculty of Theology to inoculation, see the Journal de

The steady evolution of scientific medicine brings us, next, to the discovery of vaccination by Jenner. Here, too, sundry vague survivals of theological ideas caused many of the clergy to side with retrograde physicians. Perhaps the most virulent of Jenner's enemies was one of his professional brethren, Dr. Moseley, who placed on the title-page of his book, Lues Bovilla, as a motto, referring to Jenner and his followers, "Father, forgive them, for they know not what they do"; this book of Dr. Moseley was especially indorsed by the Bishop of Dromore. In 1798 an Anti-vaccination Society was formed by physicians and clergymen, who called on the people of Boston to suppress vaccination, as "bidding defiance to Heaven itself, even to the will of God," and declared that "the law of God prohibits the practice." As late as 1803, the Rev. Dr. Ramsden thundered against vaccination in a sermon before the University of Cambridge, mingling texts of Scripture with calumnies against Jenner; but Plumptre and the Rev. Rowland Hill in England, Waterhouse in America, Thouret in France, Sacco in Italy, and a host of other good men and true, pressed forward, and at last science, humanity, and right reason gained the victory. Most striking results quickly followed. The diminution in the number of deaths from the terrible scourge was amazing. In Berlin, during the eight years following 1783, over four thousand children died of the small-pox; while during the eight years following 1814, after vaccination had been largely adopted, out of a larger number of deaths there were but five hundred and thirty-five who died of this disease. In Würtemberg, during the twenty-four years following 1772, one in thirteen of all the children died of small-pox, while during the eleven years after 1822 there died of it only one in sixteen hundred. In Copenhagen, during twelve years before the introduction of vaccination, fifty-five hundred persons died of small-pox, and during the sixteen years after its introduction only one hundred and

Barbier, vol. vi, p. 294; also the Correspondance de Grimm et de Diderot, vol. iii, pp. 259 *et seq.* For bitter denunciations of inoculation by the English clergy, and for the noble stand against them by Madox, see Baron, Life of Jenner, vol. i, pp. 231, 232, and vol. ii, pp. 39, 40. For the strenuous opposition of the same clergy, see Weld, History of the Royal Society, vol. i, p. 464, note. Also, for its comical side, see Nichols's Literary Illustrations, vol. v, p. 800. For the same matter in Scotland, see Lecky, History of the Eighteenth Century, vol. ii, p. 83. For New England, see Green, History of Medicine in Massachusetts, Boston, 1881, pp. 58 *et seq.* Also Chapter X of the Memorial History of Boston, by the same author and O. W. Holmes. For letter of Dr. Franklin, see Massachusetts Historical Collection, second Series, vol. vii, p. 17. Several most curious publications issued during the heat of the inoculation controversy have been kindly placed in my hands by the Librarians of Harvard College and of the Massachusetts Historical Society, among them A Reply to Increase Mather, by John Williams, Boston, printed by J. Franklin, 1721, from which the above scriptural arguments are cited. For the terrible virulence of the small-pox in New England up to the introduction of inoculation, see McMaster, History of the People of the United States, first edition, vol. i, p. 30.

fifty-eight persons died of it throughout all Denmark. In Vienna, where the average yearly mortality from this disease had been over eight hundred, it was steadily and rapidly reduced, until in 1803 it had fallen to less than thirty; and in London, formerly so afflicted by this scourge, out of all her inhabitants there died of it in 1890 but one. As to the world at large the result is summed up by one of the most honored English physicians of our time in the declaration that "Jenner has saved, is now saving, and will continue to save in all coming ages, more lives in one generation than were destroyed in all the wars of Napoleon."

It will have been noticed by those who have read this history thus far that the record of the Church generally was far more honorable in this struggle than in many which preceded it: the reason is not difficult to find; the decline of theology inured to the advantage of religion, and religion gave powerful aid to science.

Yet there have remained some survivals in both branches of the Western Church which may be regarded with curiosity. A small body of perversely ingenious minds in the medical profession in England have found a few ardent allies among the less intellectual clergy. The Rev. Mr. Rothery and the Rev. Mr. Allen, of the Primitive Methodists, have for sundry vague theological or metaphysical reasons especially distinguished themselves by opposition to compulsory vaccination; but it is only just to say that the great body of the clergy have at last taken the better view.

Far more painful has been the recent history of the other great branch of the Christian Church—a history developed where it might have been least expected; the recent annals of the world hardly present a more striking antithesis between Religion and Theology.

On the religious side few things in the history of the Roman Church have been so beautiful as the conduct of its clergy in Canada during the great outbreak of ship-fever among immigrants at Montreal about the middle of the present century. Day and night the Catholic clergy of that city ministered fearlessly to those victims of sanitary ignorance; fear of suffering and death could not drive these ministers from their work; they laid down their lives cheerfully while carrying comfort to the poorest and most ignorant of our kind: such was the record of their religion. But in 1885 a record was made by their theological spirit: in that year the small-pox broke out with great virulence at Montreal. The Protestant population escaped almost entirely by vaccination, but multitudes of their Catholic fellow-citizens, under some vague survival of the old orthodox ideas, refused vaccination and suffered fearfully. When at last the plague became so serious that travel and trade fell off greatly and quarantine began to be

established in neighboring cities, an effort was made to enforce compulsory vaccination. The result was, that large numbers of the Catholic working population resisted and even threatened bloodshed. The clergy at first tolerated and even encouraged this conduct; the Abbé Filiatrault, priest of St. James's Church, declared in a sermon that, "if we are afflicted with small-pox, it is because we had a carnival last winter, feasting the flesh, which has offended the Lord; . . . it is to punish our pride that God has sent us small-pox." The clerical press went further: the Étendard exhorted the faithful to take up arms rather than submit to vaccination, and at least one of the secular papers was forced to pander to the same sentiment. The Board of Health struggled against this superstition, and addressed a circular to the clergy, imploring them to recommend vaccination; but, though two or three complied with this request, the great majority were either silent or openly hostile. The Oblate Fathers, whose church was situated in the very heart of the infected district, continued to denounce vaccination; the faithful were exhorted to rely on devotional exercises of various sorts; under the sanction of the hierarchy a great procession was ordered with a solemn appeal to the Virgin, and the use of the rosary was carefully specified.

Meantime, the disease, which had nearly died out among the Protestants, raged with ever-increasing virulence among the Catholics; and the truth becoming more and more clear, even to the most devout, proper measures were at last enforced and the plague was stayed, though not until there had been a fearful waste of life among these simple-hearted believers, and germs of skepticism planted in the hearts of their children which will bear fruit for generations to come.*

Another class of cases in which the theologic spirit has allied itself with the retrograde party in medical science is found in the history of certain remedial agents; and first may be named cocaine. As early as the middle of the sixteenth century the value of coca had been discovered in South America; the natives of Peru prized

* For the opposition of conscientious men to vaccination in England, see Baron, Life of Jenner, as above; also vol. ii, p. 43. Also, Duns's Life of Simpson, London, 1873, pp. 248, 249. Also, Works of Sir J. Y. Simpson, vol. ii. For a multitude of statistics showing the diminution of small-pox after the introduction of vaccination, see Russell, p. 380. For the striking record in London for 1890, see an article in the Edinburgh Review for January, 1891. The general statement referred to was made in a speech some years since by Sir Spencer Wells. For recent scattered cases of feeble opposition to vaccination by Protestant ministers, see William White, The Great Delusion, London, 1885, *passim*. For opposition of the Roman Catholic clergy and peasantry in Canada to vaccination during the small-pox plague of 1885, see the English, Canadian, and American newspapers, but especially the very temperate and accurate correspondence in the New York Evening Post during September and October of that year.

it highly, and two Jesuits, Acosta and Don Antonio Julian, were converted to this view; but the conservative spirit in the Church was too strong; in 1567 the Second Council of Lima, consisting of bishops from all parts of South America, condemned it, and two years later came a royal decree declaring that "the notions entertained by the natives regarding it are an illusion of the devil."

As a pendant to this singular mistake on the part of the older Church came another committed by many leading Protestants. In the early years of the seventeenth century the Jesuit missionaries in South America learned from the natives the value of the so-called Peruvian bark in the treatment of ague; and in 1638 the Countess of Cinchona, Regent of Peru, having derived great benefit from the new remedy, it was introduced into Europe. Although with its alkaloid, quinine, it is perhaps the nearest approach to a medical specific, and has diminished the death-rate in certain regions to an amazing extent, its introduction was bitterly opposed by many conservative members of the medical profession, and in this opposition large numbers of ultra-Protestants joined, out of hostility to the Roman Church. In the heat of sectarian feeling the new remedy was stigmatized as "an invention of the devil"; and so strong was this opposition that the new medicine was not introduced into England until 1653, and even then its use was long held back, owing mainly to anti-Catholic feeling.

What the theological method on the ultra-Protestant side could do to help the world at this very time is seen in the fact that, while this struggle was going on, Hoffman was attempting to give a scientific theory of the action of the devil in causing Job's boils. This effort at a *quasi*-scientific explanation which should satisfy the theological spirit, comical as it at first seems, is really worthy of serious notice, because it must be considered as the beginning of that inevitable effort at compromise which we see in the history of every science when it begins to appear triumphant.*

But I pass to a typical conflict in our days, and in a Protestant country. In 1847 James Young Simpson, a Scotch physician, who afterward rose to the highest eminence in his profession, having advocated the use of anæsthetics in obstetrical cases, was immediately met by a storm of opposition. This hostility flowed from an ancient and time-honored belief in Scotland. As far back as the year 1591, Eufame Macalyane, a lady of rank, being charged

* For the opposition of the South American Church authorities to the introduction of coca, etc., see Martindale, Coca, Cocaine, and its Salts, London, 1886, p. 7. As to theological and sectarian resistance to quinine, see Russell, pp. 194, 253. Also Eccles; also Meryon, History of Medicine, London, 1861, vol. i, p. 74, note. For the great decrease in deaths by fever after the use of Peruvian bark began, see statistical tables given in Russell, p. 252; and for Hoffman's attempt at compromise, ibid., p. 294.

with seeking the aid of Agnes Sampson for the relief of pain at the time of the birth of her two sons, was burned alive on the Castle Hill of Edinburgh; and this old theological view persisted even to the middle of the nineteenth century. From pulpit after pulpit Simpson's use of chloroform was denounced as impious and contrary to Holy Writ; texts were cited abundantly, the ordinary declaration being that to use chloroform was "to avoid one part of the primeval curse on woman." Simpson wrote pamphlet after pamphlet to defend the blessing which he brought into use; but the cause seemed about to be lost, when he seized a new weapon, probably the most absurd by which a great cause was ever won: "My opponents forget," he said, "the twenty-first verse of the second chapter of Genesis; it is the record of the first surgical operation ever performed, and that text proves that the Maker of the universe, before he took the rib from Adam's side for the creation of Eve, caused a deep sleep to fall on Adam." This was a stunning blow, but it did not entirely kill the opposition; they had strength left to maintain that the "deep sleep of Adam took place before the introduction of pain into the world—in a state of innocence." But now a new champion intervened—Thomas Chalmers; with a few pungent arguments from his pulpit he scattered the enemy forever, and the greatest battle of science against suffering was won. But this victory was won not less for religion: wisely did those who raised the monument at Boston to one of the discoverers of anæsthetics inscribe upon its pedestal the words from our sacred text, "This also cometh from the Lord of hosts, which is wonderful in counsel and excellent in working."*

Progress in medical science within the past quarter of a century has been vast indeed; the theological view of disease has greatly faded, and the theological hold upon medical education has been almost entirely relaxed. In three great fields especially, discoveries have been made which have done much to disperse the atmosphere of miracle. First, there has come in more knowledge regarding the relation between imagination and medicine, and, though still defective, it is of great importance. This relation has been noted during the whole history of the science. When the soldiers of the Prince of Orange, at the siege of Breda in 1625, were dying of scurvy by scores, he sent to the physicians "two or three small vials filled with a decoction of camomile, wormwood, and camphor, gave out that it was a very rare and precious medicine—a medicine of such virtue that two or three drops sufficed to impregnate a gallon of water, and that it had been obtained from the East with great difficulty and danger";

* For the case of Eufame Macalyane, see Dalyell, Darker Superstitions of Scotland, pp. 130, 133. For the contest of Simpson with Scotch ecclesiastical authorities, see Duns, Life of Sir J. Y. Simpson, London, 1873, pp. 215–222, and 256–260.

this statement, made with much solemnity, deeply impressed the soldiers; they took the medicine eagerly, and great numbers recovered rapidly. Again, two centuries later, young Humphry Davy, being employed to apply the bulb of the thermometer to the tongues of certain patients at Bristol, after they had inhaled various gases as a cure for disease, and finding that the patients supposed this application of the thermometer-bulb was the cure, finally wrought cures by this application alone, without any use of the gases whatever. Innumerable cases of this sort have thrown a flood of light upon such cures as those wrought by Prince Hohenlohe, by the "metallic tractors," and by a multitude of other agencies temporarily in vogue, but, above all, upon the miraculous cures which in past ages have been so frequent and of which a few survive.

The second department is that of Hypnotism. Within the last half-century many scattered indications have been collected and supplemented by thoughtful, patient investigators of genius, and especially by Braid in England and Charcot in France. Here too great inroads have been made upon the province hitherto sacred to miracle, and in 1888 the cathedral preacher, Steigenberger of Augsburg, sounded an alarm. He declared his fears "lest accredited church miracles lose their hold upon the public," denounced hypnotism as a doctrine of demons, and ended with the singular argument that, "inasmuch as hypnotism is avowedly incapable of explaining all the wonders of history, it is idle to consider it at all." But investigations in hypnotism still go on, and are to do much in the twentieth century to carry the world yet farther from the realm of the miraculous.

Finally, in a third field science has won a striking series of victories. Bacteriology, beginning in the researches of Leeuwenhoek in the seventeenth century, continued by O. F. Müller in the eighteenth, and developed or applied with wonderful power by Ehrenberg, Cohn, Pasteur, Koch, Lister, Billings, and their compeers in the nineteenth, has explained the origin, and proposed prevention or cure, for various diseases widely prevailing, which until recently have been generally held to be "inscrutable providences."

In summing up the history of this long struggle between Science and Theology two main facts are to be noted: First, that in proportion as the world approached the "Ages of Faith" it receded from ascertained truth, and in proportion as the world has receded from the "Ages of Faith" it has approached ascertained truth; secondly, that in proportion as the grasp of theology upon education tightened medicine declined, and in proportion as that grasp has relaxed medicine has been developed.

The world is hardly beyond the beginning of medical discov-

eries. Yet they have already taken from theology what was formerly its strongest province, sweeping away from this vast field of human effort that belief in miracles which for more than twenty centuries has been the main stumbling-block in the path of medicine; and, in doing this, they have cleared higher paths, not only for science, but for religion.*

OUR GRANDFATHERS DIED TOO YOUNG.

By Mrs. H. M. PLUNKETT.

THE chronic pessimist, who is convinced that all true wisdom died long ago with some old moldering ancestor, and who believes that the world and all its arrangements are daily waxing worse and worse, is frankly warned to skip this article, for he will find nothing in it to sustain his cheerless and pestilent views, nor to comfort his grumbling and disagreeable soul.

All students of vital statistics are now thoroughly agreed as to the actual lengthening of the average period of human life, and facts will be adduced to show on what their faith is grounded; and an attempt will be made to point out the many and encouraging factors that have helped to achieve the result.

In discussing so lofty a topic as the steady lengthening of human life in all civilized countries in these later times—properly rated as the highest earthly interest—it is almost humiliating to learn that the earliest revelation of the cheerful fact came through a thrill in the pocket-nerve.

In England, at the close of the first quarter of this century, it began to be perceived that the Government was losing money in paying its annuities calculated on the same basis as those that

* For rescue of medical education from the clutch of theology, especially in France, see Rambaud, La Civilisation Contemporaine en France, pp. 682, 683. For miraculous cures wrought by imagination, see Tuke, Influence of Mind on Body, vol. ii. For the opposition to scientific study of hypnotism, see Hypnotismus und Wunder: ein Vortrag, mit Weiterungen, von Max Steigenberger, Domprediger, Augsburg, 1888, reviewed in Science, February 15, 1889, p. 127. For a recent statement regarding the development of studies in hypnotism, see Liégois, De la Suggestion et de Somnambulisme dans leurs Rapports avec la Jurisprudence, Paris, 1889, chap. ii. As to the miraculous in general, for perhaps the most remarkable of all discussions on the subject, see Conyers Middleton, D. D., A Free Inquiry into the Miraculous Powers which are supposed to have subsisted in the Christian Church, London, 1749. For probably the most complete and judicially fair discussion of it, see Lecky, History of European Morals, vol. i, chap. iii; also his Rationalism in Europe, vol. i, chaps. i and ii; and for, perhaps, the boldest and most suggestive of recent statements regarding it, see Max Müller, Physical Religion, being the Gifford Lectures before the University of Glasgow for 1890, London, 1891, lect. xiv. See also, for very cogent statements and arguments, Matthew Arnold's Literature and Dogma, especially chap. v, and, for a recent utterance of great clearness and force, Prof. Osler's address before the Johns Hopkins University, given in Science for March 27, 1891.

had been sold in the last century. These annuities may be briefly described as the paying of a certain annual sum for a number of years calculated on the probable number of years the annuitant may live, in return for a "lump sum" given by him to the Government. Several such series of annuities had been issued by the Government when in dire distress for funds, and found highly profitable; but now it became apparent that the Government was losing money, and a searching inquiry by authorized experts, plainly showed that the men who were receiving the annuities were living too long—a state of things that demanded reform; and, as wholesale murder could not be indulged in, the problem was attacked from the other side, and by a more extended and careful set of investigations an equitable basis for the issuance of future annuities was found. At this time it was clearly shown that the duration of life in 1725 compared to that in 1825 was as three in the former to four in the later time.

We, who are born into this age of tabulated statistics, can form but a feeble notion of the slender grounds on which those misleading annuities were founded. True, more than five hundred years B. C. the Romans had begun a register of citizens, including sex and the dates of birth and death, which was continued for a thousand years; and, from a study of it, the average period of human life was computed at thirty years. There are no life-tables at all reliable now that are over fifty years old. The first English census worthy of the name was taken in 1851; but it is a curious and valuable circumstance that while Geneva in Switzerland was undergoing the inevitable ferment caused by the presence of such an agitator as John Calvin, she did, in 1551—just three centuries ahead of England—set up such a recording and tabulation of her citizens as makes the records invaluable as a means of comparison, and shows that, from a death-rate of forty in the thousand previous to 1600, it had fallen before 1800 to twenty-nine in the thousand, and there has been a steady decrease since; so that the average of human life in that city was computed fifty years ago at more than forty-five years—a gain of one half over the Roman average.

France also set herself at the problem of life-values. Baron Delessert—the founder of the Philanthropic Society of Paris—found that the annual death-rate in that city during the age of chivalry—the fourteenth century—was one in sixteen; during the seventeenth, one in twenty-six; and in 1824, one in thirty-two. Taking all of France together, the deaths during 1781 were one in twenty-nine; but in the five years preceding 1829 they were one in thirty-nine. Thus the value of life in France had nearly doubled since "the good *old* times."

It was next found that, in the prisons of England, which were

already experiencing the good effects of greater cleanliness, better food, and other reforms, introduced through the efforts of Howard and his coadjutors, the health of the prisoners was so much benefited and their lives so much prolonged that, as Mr. Beecher said "people might sigh for a location in some good salubrious prison." So great were the advances on all sides, that Sir Edwin Chadwick, the father of sanitation, so far as it can be defined (Steps to abolish Disease and to defer Death), became persuaded that there is a potential longevity in men of one hundred years, and that death at a period less than that should be counted premature. He was born in 1800 and died July 5, 1890; and if it is true, as many statisticians assert, that the period of human life has lengthened nine years since this century began, we can see that his belief was not altogether the dream of an enthusiast; for, in spite of the great advances made in the science of sanitation, and in the art of living so as to insure the highest health, he felt that only a beginning had been made, and that the coming century is to be the one in which the seeds planted in this are to attain their growth and bear their full fruitage.

In seeking the reasons for this advance, they all might be summed up in the one great sweeping fact of the mastery of man over the forces of Nature, through the grand scientific triumphs that began with the discovery of oxygen in 1774, and the control of steam and electricity obtained a little later. When we come to details, we find the first great universal factor is the better supplies of food, produced in greater quantities and with less labor than formerly through the intelligent application of agricultural chemistry, and the use of the marvelous myriads of agricultural machines, which stand for armies of laborers, who don't get tired and don't eat. When a Montana farmer can grow on one prize acre nine hundred and seventy-four bushels of good potatoes, the disciples of Malthus even can take heart, for Mr. Edward Atkinson has conclusively demonstrated that the food-producing areas of this country have as yet only been scratched over and worked at one corner. In Queen Elizabeth's time a statistical writer says that in London the deaths from starvation were not more than one in a thousand. At that rate the deaths in London now would be twelve hundred and fifty annually, while the fact is that the few deaths from that cause now are from suicidal mania and obstinate refusal to make application for the relief provided for the destitute. Linked with the foregoing is the rapid intercommunication of nations and the speedy transportation which has practically put an end to the great famines which formerly destroyed millions in Europe and Asia, and paved the way for "plagues" in reducing the vitality of the inhabitants. A well-to-do American laborer can to-day command a more whole-

some variety of nutritious food than could the lord of the middle ages.

Next, the invention of machinery has so increased the supplies of clothing, and increased intercommunication has so aided in its distribution, that the protection and comfort of mankind have been immeasurably enhanced, while a better knowledge of the hygiene of clothing has prolonged many a life. The single item of waterproof garments and rubber shoes has saved so many lives that the philanthropist ought to rejoice that just as the cry began to go up, "The Brazilian forests are becoming exhausted," Stanley opened up boundless stores of rubber in Africa.

The next great and widely operating cause of lengthened life has been the extensive application of drainage-works, undertaken primarily to give a higher agricultural value to land, but incidentally causing an abatement in fever and ague and all other types of malarial disease, and also greatly lessening the cases of consumption—as damp soil is now recognized as *the* great predisposing cause of lung diseases. In Birmingham, England, where the drainage was good, the deaths were one in forty, in spite of many insalubrious manufactories; while in Liverpool, where an undrained soil counteracted many sanitary advantages, they were one in thirty-one. By the drainage of the Bay Ridge district of Long Island, under an intelligent and judicious commission, not only were malarious swamps changed into fertile corn-fields, but the druggists testified that they sold one quarter only of the quinine used before, and the resident physicians that there was a cessation of chills and fever and all types of intermittent and remittent fever. It should be noted, in passing, that *all* the landowners joined; one obstinate obstructionist can nullify the good intentions of a multitude of right-minded men.

We now begin to come upon the widely operating reforms consequent on the investigations and recommendations of sanitarians; the first and greatest of which is the supply to multitudes of communities of pure water; sometimes tapping an uncontaminated supply by a pipe, and sometimes going below the element of danger by an artesian well or other method of securing protected water and thereby saving thousands from attacks of typhoid and fatal diarrhœal diseases. It is beginning to be learned that constantly drinking impure water creates a lowered vitality as much as breathing a vitiated air, and that either one helps to supply ready-made victims for any of the epidemic diseases.

The next great sanitary reform has been a knowledge of the true principles of ventilation. The need of pure air—air that has not previously been breathed by another person—is by no means as well understood as could be wished, but enlightenment is surely making its way, and ancient evils are vanishing before it. A

whole article would be insufficient to show how knowledge on this subject, not understood in its rudiments fifty years ago, has advanced. Typhus, or ship fever, a disease most easily and directly communicable from person to person, is now known, when it arises spontaneously, to be the fruit of rebreathed air. It formed the "plagues" of the earlier centuries; there are still spots in London—infected houses—from which typhus is never absent, and in 1839 five per cent of the tailors of London died of it; it is to get rid of it, in large measure, that the wholesale demolition of London "rookeries" is at this moment going on. When men ceased to weave in their own unventilated hovels, and were gathered together in high, airy, light factory rooms, it was very soon seen that the number of consumptives, hunchbacks, and bow-legged diminished—an unanswerable testimony to the value of light and air in saving and prolonging lives. When it was shown that the annual death-rate from preventable typhus, which attacked persons in the vigor of life, was double that of the allied armies at Waterloo, England began to suspect that there was a commercial value to a man's life, and enacted laws for its protection; indeed, public sentiment on this matter has become so educated that no employer would dare to crowd eighty workmen into a space where the "cubic feet of air" to each was less than one hundred feet—less than one tenth of that required for healthful breathing. The reduction of the deaths of children in a single hospital, by having it well ventilated, from 2,944 out of a total of 7,650 down to 279, convinced the most stolid conservative that "there was something in it." It seems to an intelligent person of to-day as if everybody, everywhere, and all the time had understood the importance of pure air; but when it is remembered that the constitution of the atmosphere has been known only a little more than a hundred years, and the vital relations of oxygen to the human blood for a much shorter period, it will be seen that the idea is wide of the fact.

Systematic sanitation began in England about fifty years ago; in America about twenty—the first State Board of Health made its first report in 1870; but thoroughly informed persons declare that among our more plastic populations, where ideas do not encounter so many vested abuses and prejudices, they have made such rapid headway that we are already abreast of the most advanced sanitary thought of Europe; some of the new Western towns have sprung, like Minerva, in full completeness, from their creators, with entire equipment of pure water-supply, perfect drainage, electric lights, and houses built on the most healthful models.

The site of the dwelling has become an object of prime importance, and public opinion has forbidden the use of swamps

as a fit place to locate the homes of artisans and laborers. The better construction of tenement-houses under the eye of vigilant sanitary inspectors has produced a truly marvelously diminished death-rate. In the mud hovels of Ireland—cabins of only one room—the average continuance of life was twenty-six and a half years, when in the rural cottages of English agricultural laborers it was from fifty to fifty-six. In the model homes for laborers that have been built within the last twenty years in London, the death-rate has been brought down lower than in the best parts of rural England. Chadwick says that houses in the wynds of Glasgow were in a worse condition than the most loathsome prisons Howard visited, with a death-rate of forty-two in the thousand; sanitation has brought it down to twenty-eight, and in corresponding quarters in London it has been brought down to seventeen or eighteen, and the rebuilding of the fifteen acres adjacent to Bethnal Green will reduce it still further.

House-drainage—synonymous with *properly constructed plumbing*—has justly engaged a large share of attention from the sanitarian. By thorough attention to it (her sewers and water-supply were right before) Boston has reduced her death-rate from thirty-one to twenty. Croydon, England, which had a death-rate of twenty-eight, has brought it down to thirteen. These are only specimens of what has become an almost universal movement among intelligent communities.

The next life-saving advance is the superior ease of warming our houses—made possible by the improved locomotion that brings the wealth of the coal-mines to our doors and enables us to maintain a steady fire from fall to spring, that diffuses a gentle warmth all over the house, and forestalls all possibility of "taking a chill" while waiting for the fire to kindle. Even the friction-match comes in for its share of the prolonging of life. Doubtless many a fatal pneumonia and pleurisy has been contracted when the luckless householder's fire had died out overnight, and he was struggling with flint, steel, and tinder-box. It is only half a century since the indispensable friction-match came into general use.

The comfort of the warmed, luxuriously furnished, storm-defying railroad-car, contrasted with the exposure and discomfort of the stage-coach, needs but to be alluded to.

Another factor that has contributed largely, no doubt, to the diminution of mortality is the cessation of intramural interments and the establishment of cemeteries—often justly described as "rural"—removed from the busy centers of population. There are no statistics on which to found a comparison, but the known chemical products of mortal decay, and the known porosity of the earth, are of themselves enough to convince the thinking

man of the expediency of removing graveyards from the abodes of the living; and here and there among the annals of sanitation are instances of sickness and death that can be traced directly to their baneful proximity.

We next come to what may be called the medical and physiological ameliorations of the woes of humanity. Thousands and thousands of lives are now saved annually in the hospitals, refuges, homes, etc., provided by Christian charity, which have mostly come into being within the last century. Multitudes of lives have been saved by antiseptic surgery alone. The hospitals have afforded such facilities for the study of disease that a partial mastery has been gained over many, especially those known to be contagious, so that when an outbreak of one of these occurs it is soon confined to the smallest possible area; isolation and disinfection do much, and the private burial of persons so dying helps to limit the mischief. Of what may be called the medical control of disease, vaccination surpasses all others in its benefits. The deaths in London alone from small-pox during the last century fell but a trifle short of two hundred thousand, and so common was it that Macaulay says a person without a pitted face was the exception; while the numbers rendered blind, deaf, and hideous as well as wretched by it are pitiful to think of. In New York, in 1878, in a population of eleven hundred thousand, there were but fourteen cases, *thanks to vaccination;* and in the German army, where vaccination is compulsory and also revaccination at stated periods, the disease has been effectually eradicated. Anti-vaccination cranks are specially invited to read the above.

Sanitation, which works so beneficently among civilians, soon gets itself applied in the army and navy. The navies of the world furnish striking examples of the prolonging of life, and, as careful records are kept in them, it doesn't remain an ambiguous quantity. Discipline can enforce cleanliness both of the man and the ship, and a good example set in the ships of one country is soon followed in those of another. The production of pure distilled water on shipboard has done much to abolish alimentary diseases among sailors, and the power of vegetables and lime-juice to defend them from scurvy appeals to the selfishness of the ship-owners, though redounding to the long life of Jack. Dampness is one of man's mortal foes, and when it is aggravated by heat it becomes ten times worse. Damp heat between decks aggravates yellow fever and is the great cause of disease in the tropics. Formerly every day saw the decks washed down, but this operation is now left to the discretion of the commanding officer. The wisdom of this arrangement is apparent from the following record of Captain Murray, commander of H. B. M.'s ship Valorous: "In 1823, after two

years' service amid the icebergs of Labrador, his ship was ordered to sail immediately for the West Indies. . . . He proceeded to the station with a crew of one hundred and fifty men, visited almost every island in the West Indies and many of the ports in the Gulf of Mexico; and, notwithstanding the transition from extreme climates, returned to England without the loss of a single man." He adds that "every precaution was used, by lighting stoves between decks and scrubbing the decks themselves with hot sand, to insure the most thorough dryness." He had learned "how to do it." When in command of the Recruit, off Vera Cruz, he lost no men, while the other ships anchored around him lost from twenty to fifty each, and constant communication was kept up, and all were exposed to the same climatic influences. Not a case of sickness even occurred on his ship. Where he said "*dryness of the ship,*" read *dryness of the house*, and one great secret of household sanitation is learned. When the first emigrant ships went to Australia, one third of the passengers died and were buried in the sea; but, through the force of sanitation applied because the shippers were compelled to alter their terms, and were paid for those landed alive, the death-rate was soon made smaller than when the same persons were living ashore.

Through the experience gained in the Crimean War, and largely under the inspiration of Miss Nightingale, a systematic application of better methods began to be made, in the hope of diminishing the awful mortality in the Indian army, and the English were not slow to appropriate the garnered wisdom of other countries. In 1858 public attention was directed to what had been called the "British Juggernaut in India." It was shown that without war or famine a regiment of a thousand men dissolved away at the rate of one hundred and twenty-five a year, so that in eight years not a man of the original thousand remained. A sanitary commission was appointed, and they investigated among other things a series of distinguished preventive sanitary works, in the town of Bonfaric, in Algeria. It was found that the death-rates had been reduced among the military from eighty to thirteen in the thousand; while the children, of whom it had been believed, as in India, that a third generation could not be raised, on account of the deadly nature of the climate, were as healthy as those in the most healthy towns of France.

Of course, sanitation under military authority can be very efficiently carried out, and every fruitful idea, whether from France or America, was acted on, with the result of reducing the death-rate for the decade preceding 1878 to less than twenty in the Indian army and twelve in the home army. In the entire British army—home, colonial, and Indian—the saving of lives in the decade under consideration was more than forty thousand.

Another great source of the lengthening of life is found in the steady advance in temperance. The ardent advocates of total abstinence may imagine this an unfounded claim, but there is not only a lessened consumption of intoxicants, but public sentiment has experienced a complete revolution since the first commission to inquire into the possibilities of improvement was appointed. The "six-bottle" and even the "one-bottle" man have gone out of fashion, and wise Christian philanthropists have learned that some bright, attractive coffee-room, or some other thing that meets the longing for social cheer, must take the place of "Joe's cozy corner," or the gin-palace. Education is beginning to tell in the same direction, and anon there will be found interesting and elevating employment for men's idle hours to complete the cure. In England the opening of the museums and galleries and other places of intellectual culture on Sundays has been found to greatly wean men and women from the gin-palace and "public."

The sanitation of schools and the wiser care of infancy and childhood save annually thousands of "innocents." In the city of New York a man who has long been on the summer corps of extra doctors for the poor says that the very poor are becoming "educated up" by the distribution of leaflets and oral instruction till they really give more intelligent care to their children than the artisan class who hire their own doctors, and, being thought to know all they need to, are often left in dense ignorance.

Few reflect on the saving of life through well-lighted streets and a well-organized police. In Queen Elizabeth's time, John Graunt, who studied the records of crime, boasts that not more than one in two thousand was murdered annually, because the guard of the city (London) was taken in turn by the citizens. At that rate the number of murders for the whole of the metropolis would be twenty-five hundred now, while the actual annual average is no more than twelve in the five million people guarded by the London police—a population almost equal to the whole of England and Wales in Elizabeth's time. No wonder that Hobbes wrote at that time of the life of man as "poor, nasty, brutish, and short"; and, although not all the reasons have been marshaled, it is equally no wonder that the thoughtful are beginning to protest against the literal meaning of "the days of our years are threescore years and ten."

NATURE takes notice of a quaint custom, dating back to Anglo-Saxon times, known as payment of "wrath silver," which was observed last year at Knightlow Hill, a tumulus between Rugby and Coventry, England. It consists of tribute payable by certain parishes in Warwickshire to the Duke of Buccleugh. The silver has to be deposited at daybreak in a hollow stone by representatives of the parishes, under penalty of the forfeiture of a white bull with a red nose and ears. The representatives afterward dined together at the duke's expense.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

V. THE MANUFACTURE OF WOOL.

By S. N. DEXTER NORTH.

I REMEMBER the interest inspired in boyhood days by a certain colored map in a curious and recondite book in my father's library. This map undertook to group the ancient world into divisions according to the raw materials principally utilized in the clothing of the people. As a boy I was impressed by the fact that the sheep's-wool and goat's-hair countries, marked on the map in red, comprised nearly the whole of its space in a broad belt running from Hispania and Gaul on the west, covering the greater portion of what is now Germany and Austria, all of Italy, much of Russia, European and Asiatic Turkey, Arabia, and Persia. The northeast corner, occupied by the vast *terra incognita* of the ancients which we now call China, was marked on the map as the only part of the globe whose people dressed in silk fabrics. Egypt was christened the home of the ancient linen manufacture, and the map was colored in a manner to indicate that flax was also indigenous in several other small sections, mostly contiguous to the upper Rhine, and all of it bordering on rivers. India stood alone, the solitary country whose primitive inhabitants possessed and utilized the priceless inheritance of cotton. The great regions north of the wool belt were vaguely outlined on the map as peopled by barbarians who clothed themselves in skins, furs, and felts, and to whom the art of weaving was presumably unknown. One fond of the contrasts of history could not fail to be struck by the fact that the British Isles, now the home of the textile industries, were included by the map-maker in this vast expanse of country where the wheel and the distaff added nothing to the comforts of life.

If we were now to construct another map on the same principle, we should find the vivid colors which stood for the several fibers on the old map so blended and run together through the great belt line of the temperate zones that neither fiber would here predominate over any other. To-day all the fibers known to the ancients are used by all the civilized people of the globe, each for the purpose for which it is found to be best adapted. Each has had an evolution peculiar to itself, and each has been the gainer by every discovery or invention that has simplified the manipulation and thus extended the use of the other.

The sheep was the first animal which man learned to domesticate for his own service, and none has proved more useful to him.

The whole object of primitive living may be said to have been compassed in the domestication of the sheep. His pelt and wool were the covering for man's nakedness, and his flesh was his food. Thus the sheep was the most important of all the instrumentalities which contributed to the evolution of the primitive man, by slow, uncertain steps, from a state of barbarism akin to that of the beasts, into the first dawn of civilization. The evolution has been accompanied by a scientific attention to the breeding of the sheep, with a view to increasing its wool-bearing powers and improving the quality of the fiber, not surpassed, if indeed it has been equaled, in the care or training of any other animal, and achieving results commensurate with the effort. The history of this evolution is hardly less interesting than that of the manufacture itself.

FIG. 1.—A MERINO RAM. Weight, 192 pounds; weight of fleece, 35 pounds.

Wool is the only fiber which possesses the felting property in any considerable degree. This quality of felting imparts to woolen fabrics a firmness, an elasticity, a strength, a warmth, and a durability altogether lacking in the products of any other fiber. There is no fiber used in textile manufacturing which has an affinity for dye equal to that of wool. Aniline colors may be fixed on this material by simply bringing the fibers into contact with the liquid containing the coloring matter. Where richness of effect is desired, and a fabric sought which shall possess all the characteristics of artistic development, wool remains, as in the days of the lost effulgent royal purple, the unrivaled material of the artisan. From the pedestal of supremacy where these characteristics placed it wool can never be dethroned.

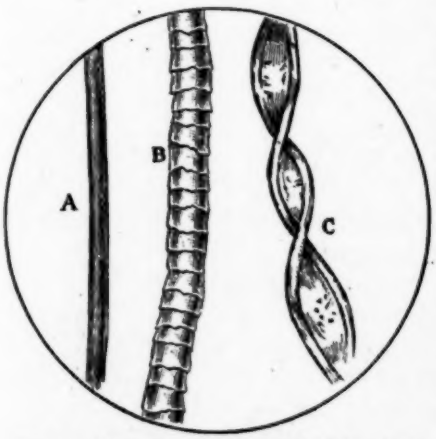

FIG. 2.—MAGNIFIED FIBERS OF (A) SILK, (B) WOOL), AND (C) COTTON.

Again, the manufacture of wool is the most laborious, the most

intricate, the most delicate, the most variable, of any of the fibers; and for this reason among others it deserves to rank, as it does, as the textile industry requiring the most brains and demanding the largest resources of art and skill. The intricacies of its manipulation are unending. They commence with the purchase of the wool itself. The variations of the fiber in quality and character and condition are almost infinite. Particular fabrics can only be produced from particular wools. The successful blending of the fiber preliminary to manufacture is an art in itself. Both the dye-house and the loom-room are schools of art, where the successful manufacturer must feel the pulse of the popular taste, and learn to minister to its whims and caprices. His weaves must change, his patterns must be varied, his coloring must be in good taste, his finish must be perfect. The broadest education in mechanics, in chemistry, in art, is necessary to the perfectly equipped woolen manufacturer.

Prior to the spinning and weaving, and undoubtedly the first artificial clothing worn by man, was the felted cloth, which originated in Asia, the cradle of the human race. Those primeval men discovered and utilized the felting property of wool—that singular peculiarity which distinguishes it from all other fibers—but without the slightest understanding of the philosophy of the property or the causes which led to it. It was not, indeed, until 1853 that the explanation of this property was revealed. In that year William Youatt, to whose investigations we owe our first real knowledge of the character of wool, discovered by the microscope that the roughness and friction of the fiber, when rubbed by the fingers in the reverse direction of its growth, were due to an indefinite number of imbricated rings, or scales, around the stem of the fiber. He detected as many as twenty-four hundred of these scales, or serrations, to an inch of fiber, and the number has since been found to reach as high as four thousand in some instances of fine Saxony wools. It is a suggestive illustration of the crab-like methods of human progress that the first utilization of wool should have grown out of a property the nature of which remained unknown down to the last generation of manufacturing.

An illustration of the intimacy of the most modern and most ancient of civilizations is found in the fact that it was left for an American citizen to first successfully essay the mechanical fabrication of felted cloths. Thomas Robinson Williams, of South Kingston, R. I., invented the process of making felted cloths of commercial length, and patented it May 22, 1830.* Since that day felts have appeared in innumerable forms—as printed

* An earlier American patent, dated October 19, 1807, was obtained by Joseph Pitkins and Timothy Kimball, hat-makers, of East Hartford, Conn., which not only covered machinery for planking hats, but "for making cloth without yarn."

and embossed piano-cloths, ladies' skirts, floor coverings, often with highly artistic designs, material for roofs and protectors against weather, piano-hammers, shoe-linings, etc. It is difficult to imagine any department of industry in which wool, in its felted form, does not somewhere play its part. Thus we have taken the simple discovery of antiquity and made it among the chief instrumentalities of civilization. The Tartars and kindred peoples who occupy the middle and northern regions of Asia, and whose manners and customs have remained unchanged from the most remote antiquity, employ the felted wool in a variety of functions, only less important than the supplying of foods. Both their clothing and their habitations have consisted of felt since a knowledge of them first went upon record in the fourth century. The process of felting was generally known among ancient nations. The Greeks gave to it the name πίληδις, from πιλέω, to compress; literally, a compression, or thickening, of the wool. The ancients employed felt for a great variety of uses, just as we do, the chief being to make coverings for the head, the most common form among the Greeks and Romans being the skull-cap.

When and where and how the discovery was made that the fiber of wool could be drawn and twisted into a thread, which in turn could be woven into a cloth, can not be told. The process devised at the dawn of civilization remains to the present day, viz., the producing of a long, continuous thread from the short fiber, and then weaving these threads into a compact network. The honor of the original discovery was claimed by all the nations of pre-Christian civilization, and probably belonged exclusively to none.

The distaff and loom must have had contemporary origin in different countries, for they were equally utilized, with little variation in form, in the spinning and weaving of wool, silk, linen, and cotton. Always it was the occupation of the women, and generally a domestic operation; although there are evidences that the factory system, so far from being a modern institution, existed three thousand years ago in Egypt, where many women spun in one building together. One of the discoveries at Pompeii is a veritable woolen factory, containing various machines for carding and weaving wool.

Spinning was the occupation of the lowly and the high born alike. Among the pastoral nations the men tended the flocks, while the women spun the wool. This arrangement of the domestic economy of the ancients has found its parallel in all countries and all ages.

The peasant's wife and daughters made their own homespun, and ladies of royal rank occupied their leisure in the fabrication of the garments with which they adorned their persons. Golden

and ivory distaffs, highly jeweled, are described by classic writers, and no theme more frequently inspired the poet than the skill and graceful movement of the beautiful spinners.

This occupation of the women continued down to the advent of the modern factory system, which has done more than all else to change the aspects of domestic life. The modern factory-girl has superseded queens and princesses in the manipulation of the fleece, and the whir of machinery and the grime of the factory town have robbed the poet of his inspiration.

The ancient distaff was generally about three feet long, commonly a stick or reed, and held under the left arm. The fibers of wool were drawn out from the projecting ball, and at the same time spirally twisted by the thumb and forefinger of the right hand. The thread so produced was wound upon the spindle until the quantity was as great as it would carry. The spindle itself, made of some light wood or reed, was generally from eight to ten inches in length. At its top was a slit or catch, to which the thread was fixed, so that the weight of the spindle might carry the thread to the ground as fast as finished. The process of primitive spinning is described by Catullus:

FIG. 3.—ANCIENT DISTAFF SPINNERS. (From Montfaucon.)

> "The loaded distaff, in the left hand placed,
> With spongy coils of snow-white wool was graced;
> From these the right hand lengthening fibers drew,
> Which into thread 'neath nimble fingers grew.
> At intervals a gentle touch was given
> By which the twirling whorl was onward driven;
> Then, when the sinking spindle reached the ground,
> The recent thread around its spire was wound,
> Until the clasp within its nipping cleft
> Held fast the newly finished length of weft."

These rhymes describe the whole process of spinning the various

yarns out of which the clothing of the people was made before the Christian era and for centuries later.

Illustrations are given of the distaff and spindle of ancient Egypt, taken thence to Greece, Rome, Padua, Miletus, referred to

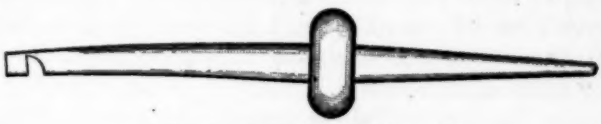

FIG. 4.—A PRIMITIVE SPINDLE.

so frequently in the Scriptures, and still used in parts of India and elsewhere. For at least thirty centuries no other means of spinning was employed.

The Egyptians wove in an upright loom, beginning at the top and weaving downward, so as to sit at their work. In Palestine the loom was also upright, but the weaver, weaving upward, was obliged to stand. There was also a horizontal loom of very ancient date, the earliest known of which was sold in London, together with some "staves," "shuttles," and a "stay," in 1316.

Just what the primitive hand-loom was we know to exactness, for there are still countries in which it is used, particularly in the manufacture of carpets, precisely as it was used before the Christian era. Ouskak, the seat of the Smyrna carpet industry, where five hundred looms are kept busy, illustrates the strength of tradition in resisting innovation as well perhaps as any locality in the world. Here to-day may be seen the female population of the town busily at work, sitting crosswise at the foot of their looms, often as many as ten in a row, each working at a two-foot width of carpet. Their looms consist of two thick poles fixed firmly in the ground; two others are joined, one above and one below, and to these the warp or chain of the carpet is fastened. The yarn is taken from bobbins suspended above their heads and tied to the warp. It is then cut with a sharp knife and the pile and woof driven together by means of a comb.

This primitive method of manufacture has the advantage of permitting a looser texture than is possible where power is used, and in consequence the colors blend more readily and beautifully, and the carpet is soft and pliant to the tread.

The Romans carried the art of wool manufacture to the highest point of perfection that it reached in ancient times. They bestowed the utmost pains upon the improvement of their breeds of sheep, and the fleeces of their finer animals sold for fabulous prices. Woolen garments formed almost the exclusive attire of the Romans, male and female, of every rank, and the enormous supplies of clothing sent to their armies prove that the manufacture must have afforded occupation to large masses of the people. Pliny's

Natural History supplies many clews to the character of the fabrics woven and worn by these chiefs among the wool manufacturers of antiquity. The excellence and variety of the fabrics they made were wonderful in view of their simple tools. The almost infinite variety of forms and textures of fabrics now familiar are simply variations of typical fabrics which these people—as great in the arts of peace as they were great in war—invented or adapted from other nations.

In the twelfth and thirteenth centuries, Florence, Venice, Pisa, and Genoa were the seats of vast wool manufactures conducted on a system somewhat akin to the modern factory system and forming the basis of the great commerce which built up those cities and made them the centers of a wealth, culture, and magnificence which modern times may rival but not surpass. Florence had attained such pre-eminence in the wool manufacture that in 1340 it had more than two hundred establishments, making annually more than eighty thousand pieces, and employing in their production thirty thousand persons. At Genoa were made all descriptions of carded and combed fabrics. The wool industry is forever associated with the discovery of the American continent, for the father of Christopher Columbus was a woolcomber at Genoa; and the great discoverer himself, in the intervals of his schooling, assisted his father in the preparation of the fleece for the spindle. From the Italian cities came the woolen cloths which for centuries clothed the world with which they traded. Thence the wool manufacture gravitated to the Netherlands, and from Flanders, its chief seat there, it spread to all the great manufacturing nations of Christendom.

During the middle ages the working of wool was conducted by small groups of special workmen in various French cities, Paris, Tours, Arras, in the gynecia of the princes and dukes, and especially in the interior and dependencies of the monasteries. In Monteil's History of the French in Different Periods is given a description of the manner of working wool in a French convent in the fourteenth century, which is worth quoting for the light it throws upon the process of manipulating wool before and at the time of Columbus's discovery, and as illustrating the similarity in methods between that time and the present: "Let us examine what operations wools of the abbey farm must undergo from the moment the sheep are sheared, up to the moment when they are placed upon the shoulders of the respectable dames of the convent. I shall first carry the wools to the boilers to get out the grease and wash them; afterward I shall spread them on the drier; as soon as they are dry I shall beat them up; and I shall sort them, and divide them into two lots. On one side I shall put the long wools, suitable for the warp; on the other, the short wools, suit-

able for the filling. I shall afterward oil the wools for the warp with hog's lard or butter; after which I shall comb them; and, since now the king finds it best that we should card the wool for the filling, I shall card them. I shall have the first spun on the distaff, and the last only on the spinning-wheel. I shall put two harnesses on the loom, for stuffs with a simple web, like cloth, and three or four harnesses for twilled stuffs, according to the kind or quality of the cloth, sometimes fourteen hundred, sometimes eighteen hundred yarns of warp. I shall full the cloths in the mill, to cleanse and felt them. I shall give them a turn of the teasles, to draw out the hair from the wool. I shall full them again, and sometimes I shall sulphur them; sometimes, also, I shall shear them with the big shears. I shall give them a light turn of the teasles when they want my cloths all ready finished. I shall repeat these operations once or twice; and, finally, if I don't want to leave my cloths in the white, I shall carry them to the dyer; if not, I shall press and colander them." The operations here quaintly described remain the same, in principle, as five centuries ago. Only the means of attaining identical results have been profoundly modified.

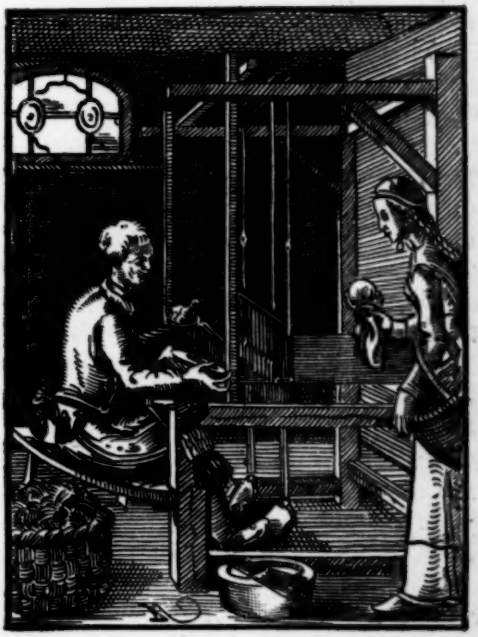

FIG. 5.—HAND-WEAVER. (From Schopfer's Panoplia, 1568.)

Outside the Low Countries, the wool manufacture had made little progress on the Continent, at the time of the discovery of America. The industry received its first great impulse in France near the close of the sixteenth century. The Edict of Nantes restored to that country the scattered merchants and workmen of the Protestant faith. They brought from the Low Countries, where they had wandered, the arts of spinning, weaving, and dyeing woolens, and founded the first establishments for making woolen cloths. The infant industries were finally planted in their present flourishing seats by Colbert, the illustrious minister of Louis XIV. Seductive offers attracted skilled artisans to her towns. The foundations were laid for the splendid industries

of Elbeuf, Sedan, Rheims, and Roubaix; and the French rapidly came to excel all the rest of Europe in the finish, coloring, and softness of their superfine cloths.

Great Britain, famous for her wool for so many centuries during which it was her chief source of national wealth, long remained dependent upon the Continent for the great bulk of her supply of the fabrics—especially the finer qualities—of which her wools formed the raw material. When Julius Cæsar invaded England he found the inhabitants of the southern portion of the island well acquainted with the spinning and weaving of both flax and wool. Wherever the Romans went they carried their arts and their manufactures with them. They were at great pains to send their best artificers to the island, forming them into colleges or guilds, endowing them with certain privileges, and placing them under the great office of the empire, the Court of Sacred Largesses. The first woolen factory was established by them at Winchester, about one hundred years after the conquest of the island, to make the clothing of their army of occupation; but, on the departure of the Romans, the woolen manufacture became practically extinct again.

There is scant evidence of any revival of the woolen manufacture in England until the time of Edward III. Early in the fourteenth century the English are spoken of contemptuously as "only shepherds and wool merchants," dependent for their clothing upon the Netherlands, the only wool weavers in Europe; but even at this time (reign of James I) wool was said to constitute nine tenths of the national wealth of England. Wool was styled "the flower and strength, the revenue and blood of England"; and from time immemorial the lord high chancellor has presided over the House of Lords on a wool-sack, which gave its name to his office, the emblem of the close association existing between the kingdom and its leading industry. Edward III, in the fourteenth century, began the systematic encouragement of the woolen industry. He attracted to England many Flemish families skilled in the art of fabricating wool, investing them with privileges and immunities beyond those of his native subjects.

The king who was wise enough to import citizens to teach his people a new art, sought also to foster its development by restrictive legislation. The exportation of English wool was forbidden, the importation of foreign cloth made illegal, no subject was permitted to wear any clothing save that of native manufacture, and finally a tax of twenty shillings a sack was imposed upon all wool entering into the home manufacture; for this shrewd king did not propose to neglect his own treasury while laying the foundations of new wealth for his people. These laws

were the beginning of a series of protective and restrictive statutes in Great Britain, relating to wool and its manufacture, which extended over a period of nearly five centuries. Sometimes this legislation was wise and beneficial; at others it hampered, by almost incredible restrictions, both the growing and the manufacturing interests. A curious study of the relations of legislation to industrial enterprise is offered by the experience of England on this subject.

The development of the industry was certainly very rapid at the commencement of this policy. At the beginning of the reign of Edward III more than half of the cloth worn in England was imported; and, in his twenty-eighth year, it is stated that the exports of cloth were threefold the imports. From that time the progress of the industry was steady, if not rapid; for in England, as everywhere else, until toward the close of the eighteenth century, the manufacture remained a hand operation, and, therefore, essentially the same operation as throughout the middle ages. Some improvements in hand-spinning and in the hand-looms were made, but they were not of a kind that radically changed processes or notably facilitated production. The advance consisted largely in the modification of patterns, the introduction of new designs, and the better application of the art of dyeing. With our present knowledge we may indeed wonder how the capacity of this hand-machinery sufficed to supply the clothing of the world. These were centuries of almost constant war, in which great armies were uniformed in wool. Occupation enough there must certainly have been for the weavers, notwithstanding the fact that there are repeated accounts in the contemporary histories of great depressions and constant dispersion of the cloth manufacture. They were nimble-fingered experts, and could perform feats at the loom which would astonish a modern-day weaver. Some of the fabrics they wove, specimens of which remain to us, were marvels of ingenuity both in pattern and coloring. We have not greatly gained upon them in any of these respects. But the advantages of machine-made cloth over hand-made are obvious, apart from greater productive capacity. No hand-spinner, however dexterous, can impart absolute uniformity to a yarn. Machinery can accomplish a uniformity so perfect that when the scales will detect the variation of the fraction of an ounce it is attributable to carelessness. For the same reason the spinning of the very light yarns, such as are used in that wonderful creation of French genius, the all-wool dress-goods—yarns as fine as two-eighties or two-nineties—was an impossibility before the application of power to spinning. No human skill, however trained and expert, can throw the shuttle with the precision of power.

The contemporary progress of civilization is shown by the fact that the textile arts were quite as fully developed in America when the existence of another continent was revealed to the Europeans as in Europe itself. Spinning and weaving had been practiced among the ancient people of Peru and Mexico for a period of time which can not be limited by any knowledge we possess, and by practically the same methods which obtained in the nations whose records came within the ken of history centuries earlier.

The Mexicans spun and wove cotton, and the Peruvians both cotton and wool, into fabrics which the Spaniards found in every way equal to anything they had known at home. The Peruvians, in particular, were adepts in the art. When Pizarro made the conquest of their country in 1533, he found in the empire of the Incas four species of animals little different from each other, which he called the sheep of the country (*carneros de la terra*), because of their general resemblance to the Spanish sheep, and the similar utilization of its fiber. Two of the species, the llama and alpaca, had been in a state of domestication from time immemorial, the remaining varieties, the vicuna and the guanaca, living in a wild state in the fastnesses of the Andes. From a variety of sources we are able to obtain minute details of the importance which the Government attached to these animals, and the large part which they played in the domestic economy of the country.

The Peruvian woolen fabrics were of three kinds—a coarse woolen cloth, which they called *avasca*, which formed the raiment of the common people; a finer variety, called *compi*, worn by the captains and officials; and still another, also called *compi*, but of much finer quality, reserved for the use of persons of royal blood. Specimens of this cloth, still preserved, reveal a fineness of texture and an exquisite finish which modern ingenuity rarely equals. Both sides of these cloths were woven alike. The delicacy of the texture gave it the luster of silk, while the brilliancy of the dyes employed excited the envy and admiration of the European artisan. The Peruvians made also shawls, robes, carpets, coverlets, and hangings in great varieties of patterns. They knew how to produce an article of great strength and durability, by mixing the hair of animals with the fleece of their llamas.

Garcilasso gives a very pretty picture of the domestic life of the Peruvians, which was largely occupied in this manufacture. There was little sewing to be done, according to his accounts, "because the cloths worn both by men and women had few seams. All they wove was first twisted. All the cloths were taken from four selvages. They did not have the warp longer than was required for each woolen shirt. The vestments were not cut out,

but were entire, just as the cloth came from the frame, for before they began to weave they settled the required length and breadth, more or less."

That these two civilizations should have existed for centuries on the American continents, with high forms of civilization, including the textile arts, developed in both, but neither in any way springing from the other, or from any European source, is not more surprising than that the rest of the population of the Western hemisphere should have been without these forms of civilization. There exist to-day communities in which the arts of spinning and weaving have never been known, and are still unknown. Wherever civilization is indigenous, there these arts have existed as one of the first evidences of it, and the progress in these fields has everywhere been indicative of the general progress of civilization and the capacity of the people of the several countries to adopt and take advantage of the new sources of wealth and comfort which steam, with the mechanical inventions of which it is parent, places at the disposal of capital and labor. The transformation of the woolen industry, through these agencies, has been complete, as we shall now show.

The Evolution of the Card.

When primitive woman made the first discovery regarding the capacity of the fleece of the sheep to be spun into a yarn, and that yarn to be woven into a cloth, she compassed the whole of the discovery with reference to wool manufacture. All that has since happened has simply been the perfecting and the enlarging of that original discovery. We still spin and we still weave; and the fabrics we make are of no firmer texture or more beautiful design than those which existed in prehistoric times. We have substituted steam for the human hand; we have simplified and multiplied processes and thus increased the variety and the amount of the product and decreased the cost of production. But throughout all the changes in yarn-spinning, the rotary spindle continues to be the essential implement; all the improvements have had for their objects, first, the application of mechanical methods for rotating the spindle; second, automatic methods for attenuating the fibers; and, third, devices for working large groups of spindles simultaneously. Weaving has always been done by warp yarns, or threads, running longitudinally, and weft or intersecting yarns thrown at right angles across the warp by hand, by hand-shuttle, or by power-shuttle. Invention seems, at first sight, to have carried the automatic principle as far as it can go, in both operations, and in all the preliminary and subsequent processes. But a study of the steps of this evolution will convince us that past inventions, so far

from diminishing the field for the exercise of the human mind in the woolen manufacture, have greatly increased it.

The evolution of the wool manufacture has not succeeded in reducing the number of the processes through which the wool must pass in its long journey from the back of the sheep to the back of man. It has only expedited and simplified them. When Dr. Ure exploited the philosophy of manufactures in 1835 he gave a list of the operatives whose separate manipulations were necessary to the woolen manufacture—twenty-four in all. The list is remarkable alike for its length and for its nomenclature—it being plain how words were coined, out of the nature of the occupation, to meet each case. In tracing the evolution of the manufacture, it is well to have this list before us:

FIG. 6.—LADIES CARDING AND SPINNING WOOL. (From a fourteenth-century MS. in the British Museum.)

"Wool-sorters, pickers, willyers (winnowers), carders, scribblers, pieceners, slubbers, spinners, warpers, sizers, weavers, scourers, dyers, burlers, fullers, boilers, giggers, driers, croppers, singers, glossers, pressers, brushers, and steamers."

Each of these names stood for a distinct process in the manufacture through which the fiber must pass before it was converted into cloth. Many of them are now known by different names, but all of them represented successive steps in the manufacture, some of which are now combined, but all of which are still necessary, and all of which, except the first, are now performed automatically, by a great variety of machines, bewildering in their number, complicated in their movement, and representing a body of inventions, as applied to all the textile industries with the necessary variations, which finds no parallel in any other of the human arts. Each of these processes was by hand up to about the middle of the last century.

It will be necessary to confine our attention in this paper to the historical development of the main processes of the manufacture—the carding, the combing, the spinning, the weaving, and

the finishing—the processes in which the mechanical advance has been fundamental. The various machines which now expedite the supplementary processes have grown out of the inventions which have attended these fundamental processes, and they are of special interest only to those practically engaged in the manufacture. Their invention has been suggested—in fact, compelled—by improvements in the primary machinery. We shall be struck, as we proceed, with the dependence of each forward step in this evolution upon some preceding advance, one invention making possible others, which without it would not have been dreamed of.

The wool comes into the mill dirty, greasy, burry, sometimes washed by the farmer, but generally just as it is sheared from the sheep, a filthy and unwholesome thing, giving little sign of the beautiful white and flossy substance into which it is soon converted. It must first be sorted, each fleece containing from six to eight qualities of sorts, which the careful manufacturer separates, devoting each quality to the purpose for which it is best suited. No skill in carding, spinning, weaving, or finishing, can possibly produce a soft or fine piece of goods from a coarse, hard fiber. When a woolen thread is to be spun to the length of 15,360 yards to a pound, or in the case of a worsted thread to twice that number of yards to a pound, everything depends upon care in the selection of the fleece and in the sorting. These sorts are impregnated with a greasy substance called the yolk or suint, caused by the animal secretions and the perspiration of the skin, a compound of potash and animal fat, which must be completely eradicated. The elimination of the yolk, dirt, and foreign substances, common to all wools, results in a shrinkage of from fifty to seventy per cent.

Our ancestors scoured their wool in tubs, much as our wives and daughters scour our clothes to-day. In the hand-washing of wool, a tub was filled with the suds, in which one or two men with long poles stirred the wool until clean, when they lifted it upon a traveling apron, which carried it between a pair of rollers which squeezed out the water. The same principle is applied in the automatic scouring now in vogue. Great forks or rakes seize the wool as it is carried by rollers from a feeding apron into the iron tanks, and by alternating motions of their teeth give it a thorough scouring. Thus cleansed, the wool is delivered by rollers to the drying machines, where hot air and great fans are now utilized to extract all the moisture without tearing the fiber. The ventilation—drying of wool by means of hot air—effects the object in one tenth of the time occupied by the old method of drying by exposure in the open air. So enormous has been the increase in the production of wool, stimulated in all quarters of the globe by the enlarged capacity for its manufacture; so different

are the quality and characteristics of these wools, collected from all countries and grown under all conditions; so illy prepared is much of it for manufacture, that the art of the manufacturer is now largely shown in the skill and care with which he selects, sorts, mixes, prepares, and treats his raw material, the processes preliminary to its carding. Potash, carbonate of soda, silicate of soda, ammonia, and soap are all more or less used in wool-scouring. So delicate is the fiber that the ingredients employed must be most carefully considered. The character of the water used is often an element which affects the fiber throughout its manipulation. Chemical science has done much to aid the manufacturer in this branch of his work. Invention has also provided steeping machines, to drive off the acid contained in the fibers, and dissolve the hard, dirty substances, without removing the yolk, which is valuable as a detergent. A preliminary machine is sometimes used to eliminate the troublesome burr, often imbedded in the fleece, and other vegetable substances which, unless wholly removed, destroy the fine finish of the goods. The use of chemical agents in the process of extracting vegetable matter, supplementing this machinery, is also a modern discovery, requiring the utmost skill and care in application to leave the fiber itself uninjured. Wool being the only substance which has absolute need to be oiled in order to be spun, this step in the manufacture occurs at the blending—that is, the mixing of the different sorts, or the cotton and shoddy—if either of these adulterants is used prior to the carding.

FIG. 7.—LADIES CARDING, SPINNING, AND WEAVING. (From a fifteenth-century MS.)

So long as spinning continued to be done on the one-thread wheel, there was no need for expediting processes in the preliminary preparation of the wool. The carding of the fleece could be done by hand, as fast as the spinners could dispose of it. Carding was done at the time of Columbus by a pair of hand-cards, which are shown in the illustration from a fifteenth-century manuscript. These cards were simply rough brushes, armed with

fine wire teeth set in leather, by which the fibers of the wool were reduced from their matted condition into a form somewhat parallel, to facilitate the spinning. With two of these brushes the operator, by repeatedly stroking one brush, laden with tufts of wool, against the other, gradually untangled and straightened them. The "cardings" were then taken carefully away from the wire bristles, and condensed into a roll, by rolling them on the back of the card, when they were ready for the spinner. Nothing could have been more primitive than this original card operation.

Some slight improvements of the hand-card preceded the invention of the cylinder machine. A frame adjusted to an inclined plane was equipped with coarse cards, on which the wool was placed. Sitting in front of this frame, the workman held in his hand a square board, also covered with cards, and carded the wool with a seesaw motion over the inclined plane. Daniel Bourne took out a patent for a carding machine in 1748, in which the principle of cylinder carding was rudely hinted at. "The cards are placed on cylinders or rollers," said his specifications, "and these act against each other by a circular motion."

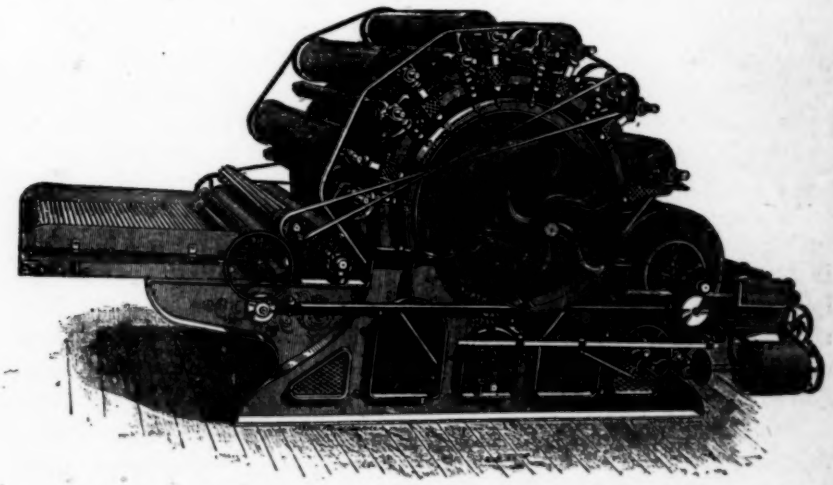

FIG. 8.—AN AMERICAN CARDING MACHINE—FIRST BREAKER.

This was the main principle of carding as now practiced. Improvements upon Bourne's machine followed rapidly. William Pennington and Robert Peel made modifications which led the way to Arkwright's "doffer comb," patented in 1775. To Arkwright also belongs the credit of the invention of the workers and strippers.

The present carding engine was evolved by successive steps at long intervals. The most important contribution to the card-

wool industry during the present century was the invention of John Goulding, of Worcester, Mass., and was patented in 1826. Before his invention the length of the rolls issuing from the carding machine was limited to the breadth of the card. The ends of the separate rolls had to be spliced together by hand, a tedious and expensive process, with the aid of a machine known as the billy. Goulding dispensed with the billy altogether, and accomplished with four machines what had previously required the use of five. The invention enabled manufacturers to produce yarn from wool at much less cost, of better quality, and in greater quantity than was produced by the old process. His machine also dispensed with short rolls and introduced the long or endless roll. Goulding's invention thus combined in the carding process operations which up to its introduction required an intermediate process before spinning to prepare the roving for the jack. The purpose of this superseded machine, called the billy or slubbing machine, was to join the detached rovings in a continuous spongy cord, to which it also imparted a slight twist and some draft. This operation had been performed in the days of hand manufacture on a spinning-wheel somewhat similar to the common spinning-wheel but smaller in size. The slubbing billy was introduced soon after Hargreaves's invention of the spinning jenny had been applied to the woolen manufacture, and closely resembled this machine in its working parts.

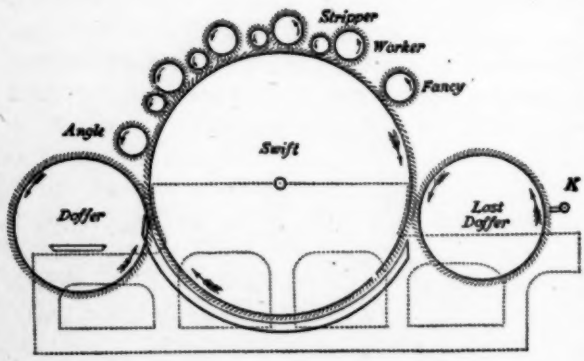

FIG. 9.—WORKING PARTS OF A CARDING MACHINE.

The cardings, as they fell from the card machine, were taken up by children, called pieceners, whose work it was to join these porous rolls by rolling their ends together with the palms of the hand, and then lay them upon the billy board, whence they were drawn upon the spindles by the movement of a carriage and wound into a conical cop. The billy usually contained from fifty to one hundred spindles, and its wheel was turned by the slubber, who must also draw the carriage. One slubber and one billy were appointed to each carding machine, and generally four pieceners. It was in this branch of the work that complaints of cruelty to children were so frequent during the earlier half of the century. It was well established in parliamentary investigations that the

slubbers frequently maltreated the children they employed. It was not until 1826, as we have seen, that the invention of Goulding, by making automatic roving possible, dispensed with the labor of children in this branch. Goulding's invention was as large a gain to humanity as to the manufacture.

Until recent years, the raw material was fed upon the cards by hand. Before the invention of feed rolls and endless apron, the wool was held in the hand against the revolving surface of the card-roller until it was seized by its teeth. Then a "feed-sheet" of cotton cloth was invented; then the lattice-apron. By both these devices the wool was taken from the feed-roll directly by the main cylinder of the card. Then came the "tumbler," interposed between the feed-rolls and the cylinder; then the wooden "licker-in" was added, and years later the metallic burr-roller, invented by Francis Alton Calvert. In 1864 a Belgian inventor, Jean Sebastian Bolette, invented a machine which measured the wool as it fed the card, and regulated the supply automatically. Still another machine, the work of an American inventor, William Calvert Bramwell, mixes as well as weighs the wool, throws out much of the remaining refuse, and permits a carding machine to turn out from twenty-five to forty per cent more work than was possible by hand-feeding. These automatic feeders, and additional series of equally ingenious machines for transferring the wool from one card to the other, and the improvement of the card itself, have enormously increased its productive capacity. Fifty pounds of clean wool a day was a very fair average for the carding engine of twenty-five years ago. This average has now increased to one hundred and one hundred and fifty pounds a day, according to the width of the carding machine and its cylinders, and the quality and character of the materials employed.

It is astonishing to watch these monster engines, grim as implements of war and death, absorb the tangled wool in their greedy jaws, draw it tenderly upon their bewildering mass of rapidly revolving wheels, cylinders, and rollers armed with sharp teeth, shake from it any remaining dirt or foreign substance, whirl it rapidly round and round and in and out, and finally deliver it in the form of a dainty, white film, which another attachment gathers automatically into balls or rolls, ready for the preliminary processes of spinning.

Modern carding accomplishes four things essential to successful manufacture: the thorough blending of the component fibers; their rearrangement in a form somewhat parallel; their final cleansing of all refuse matter; and their union and condensation into a continuous thread called the sliver. To accomplish these ends with the utmost speed, with a minimum of waste, without injury to the delicate fiber, is the function of the modern carding

machines. In a general way the process is that of carding cotton, but the resemblance is only general. Between the carding machinery and the loom, in the wool manufacture proper, there is now but one machine, the mule or frame; but in the manipulation of cotton there are several machines between card and loom, and the doublings amount to thousands. Thus the carding process in the woolen manufacture is the most important of all in one sense, instead of the spinning, as in cotton manufacture.

There are two systems of carding now in common use. That most generally adopted in the woolen manufacture in England consists of a scribbler, containing two swifts, an intermediate, also with two swifts, and a carder, containing two swifts and a condenser. The system universally in vogue in this country in the woolen manufacture has the same set of three machines (called here the first breaker, the second breaker, and the finisher), but each engine having but one swift or large cylinder, as in the illustration here given. Both systems produce satisfactory results. Each of these three machines is nearly similar, and each advances the material from the other. The main organ of a card is the cylinder, generally about four feet in diameter, and covered with card clothing, not different in principle from the primitive clothing above described. Around this cylinder revolve several smaller cylinders, similarly clothed, called workers, which continually remove the wool from the main cylinder, separating the fibers and combing them. From the workers, as they become saturated with wool, it is removed by another roll with longer teeth, called the "fancy," which revolves at a higher speed. The carded wool is then removed by the "doffer," and passes on to the second and third machine, to undergo the same process twice more, each time by finer card clothing, until it is finally removed by a pair of small rollers called condensers. These condensers, one above the other, have strips of card clothing affixed, which alternate. Thus the wool is taken off in long strips, which pass through more condensing rollers which are given a transverse rectilinear motion, the combination of these two giving a soft and twisted thread of woolen yarn or sliver.

Some conception of the amount of dislocation and blending of fibers to which these carding engines subject the wool is possible from the fact that there are upward of fifty-six million teeth or points in an ordinary English card, fifty millions of which come in contact with the wool, separating and carrying it forward, six millions playing the part of extractors, drawing the fibers from the teeth of the other rollers. Prof. Beaumont estimates that, in an ordinary scribbling engine, the wool is continually subjected to the disturbing and intermixing action of twenty-five thousand points. Remembering that this operation is three times per-

formed, we can imagine how complete is the transformation to which the sorts of wool are subjected in the carding process. We can thus readily understand how much more perfect is the carding operation, as now performed by machinery, than anything that was possible under hand manipulation.

QUESTIONS CONCERNING THE MINOR PLANETS.

By M. F. F. TISSERAND, of the Institute of France.

KEPLER, having found a break in the continuity of the mean distances of the planets from the sun, boldly filled it by supposing a new planet between Mars and Jupiter. The publication of Bode's empiric law in 1772 helped confirm the ideas of Kepler, and fixed the distance of the hypothetical planet at 2·8 times that of the earth. A new authority was given to this conclusion after the discovery of Uranus by William Herschel in 1781. The calculations of Lexell and Laplace showed in fact that Uranus's distance might have been furnished in advance, with a near approach to exactness, by Bode's law. At a conference held in Gotha in 1796, Lalande and De Zach proposed to search for the unknown planet, and to divide the labor among twenty-four astronomers, each of whom should examine an hour of the zodiac.

On the first day of this century—that is, January 1, 1801—Piazzi discovered at Palermo a star which he took at first for a little comet and observed several times till the 11th of February following, when illness stopped his work. Bode was the first to recognize that the star could not be a comet, and thought that in Ceres Piazzi had found the planet suspected by Kepler. When Piazzi had become well again, he did not know where to look for Ceres. It was to be sought for toward the end of the year, after coming out from the glare of the sun, but no data were at hand for determining its position except the geocentric arc of 3° which it had traversed during the forty days it had been under observation.

Here Gauss came to the rescue; he was then twenty-four years of age, and had had little or nothing to do with astronomical calculations, having been occupied chiefly with the higher arithmetic. In less than a month he invented an admirable method for calculating the elements of the elliptical orbit of Ceres and an ephemeris, by means of which Olbers found the star again on the first day of January, 1802. The mean distance of Ceres from the sun is 2·77. It corresponds exactly with Bode's law, and fills the gap, but with a very modest planet, having a diameter of only about 200 miles.

Olbers's discovery, on the 28th of March, 1802, of a second planet, Pallas, revolving around the sun at the same mean distance as Ceres, presented the question under a new aspect. Gauss's calculation showed that Ceres and Pallas might, in time, come to pass very near each other on the line of intersection described as A B of the planes of their several orbits. Olbers was thus led to think that the two little bodies might be fragments of a greater planet which had been broken up by an internal commotion. If this were the case, there would probably be other fragments, the orbits of which would pass the line A B, so that by watching the two points A and B, where this line strikes the celestial sphere, chances might occur of seeing the fragments of the primitive planet pass. Eventually Harding found Juno near A in 1804, and Olbers discovered Vesta near B in 1807.

Further researches, carried on by Olbers till 1816, brought no result; and it was not till 1845 that a fifth body, still smaller than the other four, was discovered by Encke. After this time, discoveries became frequent and regular, till now 299 are known.* But the size of the new stars keeps getting smaller: the first four were between the sixth and the eighth magnitudes; the two discovered by Encke were of the ninth; and those which are now discovered from time to time seldom exceed the thirteenth magnitude. William Herschel, in consideration of the small size of these bodies, and hardly regarding them as sufficient to fill the place of a planet, thought it more fitting to call them asteroids than planets.

A survey of the orbits of the asteroids as a whole will help us to gain clearer ideas respecting them, and may bring out a few simple relations that will cast some light on the origin of the bodies. The supposition of Olbers is not sustained. Prof. Newcomb, having studied the orbits of the first forty asteroids, found that, as they move to-day, they are far from passing in the same line. Even the hypothesis that the geometrical condition supposed may once have existed, but has been changed by the perturbations caused by the attractions of the other planets, is contradicted by the calculations.

But this hypothesis, though it must be abandoned, has the credit of having provoked the discovery of Juno and Vesta, and of having suggested Lagrange's theory of the origin of comets, to which M. Faye has added a number of curious speculations, and by the aid of which we may, perhaps, some day find an explanation of the origin of meteors. The smallest mean distance from the sun of the known asteroids, 149, is 2·13 (times the mean distance of the earth); the greatest, that of 279, 4·26; the corre-

* Since increased to 308.

sponding periods of rotation are 3·11 and 8·81 years. They both revolve, therefore, on either hand, outside of the limit, 2·8, assigned by Bode's law. If we take account of the eccentricities, 131 comes within the distance 1·31 from the sun, and 175 goes as far as 4·73 from it. The asteroids, therefore, perform their movements within a very extended zone, and the *ensemble* of their positions forms a kind of ring, the breadth of which is more than three times the distance of the earth from the sun. A comparison of the eccentricities shows a mean of 0·15, much higher than the corresponding mean, 0·86, of the older planets. This, too, indicates that there are notable differences in the conditions of their formation. The difference is still more striking in the inclinations of their orbits. The mean of the inclinations is 8°, a little higher than that of Mercury and that of the equator of the sun. But of two hundred and ninety-three asteroids, there are seventeen that have inclinations higher than 20°. When their mean distances are also considered, these seventeen seem to arrange themselves in two groups, around the distances 2·75 and 3·15 respectively; but this appears to be only because asteroids are more numerous in those two regions. It is also noteworthy that the much inclined orbits are usually also very eccentric, but the converse does not hold. A great eccentricity does not seem to involve of necessity a great inclination.

The question may arise whether the asteroids may not all at first have been placed in orbits of slight eccentricity and slightly inclined to the plane of the ecliptic, and their eccentricities and inclinations then have increased considerably—at least those of some of them—under the influence of perturbations. The researches of Lagrange and Laplace have shown that the eccentricities and inclinations of the old planets could vary under the influence of their mutual attractions only within narrow limits. But this result is established only for determined distances of the planets from the sun. Is it sure in advance for other intermediate positions, and particularly for the space in which the asteroids move? Leverrier asked this question, and made the curious remark on the subject that there exists, between Jupiter and the sun, a region in which, if we place a small mass, in an orbit but little inclined to that of Jupiter, that mass will leave its primary orbit and attain large inclinations to the plane of the orbit of Jupiter and to that of Saturn. It is remarkable that this position is at nearly twice the distance of the earth from the sun—that is, near the interior edge of the zone in which the minor planets are found. This fact, interesting as it is in itself, does not explain the large inclinations that have been determined at the distances 2·15 and 3·15, which are very different from those indicated by Leverrier as those at which a certain amount of in-

clination may be produced. I made a similar research a few years ago concerning eccentricities, and found a region of instability corresponding with a still smaller distance from the sun, 1·83. The perturbations caused by Jupiter and Saturn must therefore be regarded as insufficient to explain the considerable values of the eccentricities and inclinations of so many asteroids. These values were never small, and consequently the conditions in which Laplace's nebula existed were not the same at the times of the formation of the asteroids as they were when the old planets were fixed. An interesting cosmological question is presented here, and the accumulation of new discoveries of asteroids can only facilitate its solution.

The distribution of the asteroids, according to their mean distances from the sun, or (which amounts to the same thing) according to their mean diurnal motions,* offers some curious facts. A table showing this factor for all the asteroids but three presents the striking feature of accumulations of minor planets about the mean motions 640″, 780″, and 815″, with which correspond the mean distances 3·13, 2·75, and 2·67. Two principal voids may also be recognized, about 600″ and 900″, or the mean distances 3·27 and 2·50 from the sun. The mean diurnal motion of Jupiter is 299·42″ or very nearly 300″. The voids that have been pointed out thus correspond with regions where the mean motion of the planet would be exactly double or triple that of Jupiter. There are other less well-defined voids, in which the relation of the mean motions to that of Jupiter, instead of being 2 or 3, would be represented by one of the fractions $\frac{4}{3}$, $\frac{5}{3}$, $\frac{5}{2}$, and $\frac{7}{2}$. Prof. Kirkwood first brought out this fact in 1866, and generalized it by saying that the parts of the zone of the asteroids in which exists a simple relation of commensurability between the period of revolution of a minor planet and that of Jupiter are represented by gaps like the intervals between the rings of Saturn. We remark in addition that the gaps are less sharply marked than in the case of the rings of Saturn, in that after a void the number of asteroids does not increase suddenly, but gradually, till it regains its normal value.

Can the voids be accounted for by the theory of perturbations? We should have a very simple explanation if we could show that two planets, the durations of whose revolutions are in a simple commensurable relation, exist for that reason in an eminently unstable condition which they are liable to abandon at any moment. If these conditions are realized, the usual theory of perturbations defaults; but we can not conclude that instability would result from it. Recent calculations seem rather to lead to opposite con-

* The mean diurnal motion is the quotient of the division of the number of seconds (1,296,000) in the circumference by the number of days of the planet's revolution.

clusions. Gauss, communicating to Bessel in 1812 the discovery of the ratio of $\frac{7}{18}$ between the mean motions of Pallas and of Jupiter, said that that value ought to be realized more and more exactly under the influence of the attraction of Jupiter, in the same way as the motions of translation and rotation of the moon are equalized. Newcomb has expressed the same opinion, to which he was led by his studies of the system of Saturn, saying that while one would think that, in the case of movements absolutely commensurable, perturbations would not fail to grow beyond limits to the point of compromising the stability of the system, the consequence is not a necessary one; there would probably be only oscillations more or less irregular, but equilibrium would be re-established incessantly. The labors of M. Gyldén and my own personal researches tend to the same conclusion.

It is therefore probable that, if the voids had not existed in the beginning, further perturbations by Jupiter would not have been sufficient to produce them; they without doubt already existed, immediately on the formation of the asteroids, and give another reason for considering the question they present as of primary interest from a cosmogonical point of view. It is of no less interest in the matter of the celestial mechanism, for it corresponds, as we have said, to a case in which the old methods default, and which has instigated the most interesting studies of the period. Laplace has already considered it in his theory of the satellites of Jupiter, but the asteroids present it to us under conditions which make its solution still more difficult.

The minor planets situated at the outer limit of the ring are interesting from several points of view. Some of them furnish a kind of transition between the asteroids and some of the periodical comets. Thus, the orbit of 175 is very like that of Tempel's periodical comet. The distinction between planets and comets, founded on the dissimilarity of their orbits, vanishes here. We have nothing left to distinguish them but their physical aspect. The asteroids of which we are speaking, being near Jupiter, are always very distant from the earth. They must, therefore, appear small in proportion to their dimensions. It is possible that, by seeking with a strong enough glass, we shall find others; and some of these may come in to corroborate the resemblances with the periodical comets. Planet 279, discovered two years ago by M. Palisa, is one of the most remarkable of the group of which we have just spoken. In 1913 it will come with the distance 1 of Jupiter, and will continue there for a considerable time. The attraction of Jupiter will then be more than one fiftieth as great as that of the sun. The calculation of the perturbations promises to be interesting and difficult,

and will make it possible to deduce the mass of Jupiter with great precision. The planets at the lower limit of the ring may, in case their orbits are very eccentric, come very near the earth—even within a distance of 0·7—in which case it will be possible to determine their parallax accurately by observing it from two distant stations, as we do the moon. Thence we can deduce the parallax of the sun; and this is one of the best methods within our reach of obtaining this fundamental element in astronomy.

We have said that it is impossible to connect all the asteroids with the rupture of a single planet; but we can form groups of two planets whose orbits present curious resemblances which do not seem due to chance only. The most interesting group is formed of the planets 37 and 66. Their orbits are nearly equal ellipses, situated almost in the same plane, and differing only in the orientation of the major axes. This almost complete identity of four of the five elements, which exists now, and will, according to the calculations, be maintained, can not be accidental. Many facts of this kind will not be needed to illustrate to us the origin and formation of the asteroids. Maia (66) was lost for fifteen years, till it was found again by the help of M. Schulhof's calculations. There are other similar groups, and more will probably be found.

I trust that this notice will show a rich harvest of interesting facts in prospective. To speak only of acquired results, it may be recollected that Gauss composed one of his finest works for the purpose of recovering Ceres. It was in seeking for a quick way of verifying Leverrier's numerical calculations upon the great inequality of Pallas that the illustrious Cauchy wrote admirable memoirs, from which great advantages are now derived for the theories of the older planets and for the most delicate points in the theory of the moon. It would be unjust, too, to forget the excellent labors of Hansen and Gyldén, which had the same origin.

The asteroids have also been the occasion of important advances in observation. The search for them has trained observers of the first order. The purpose of following them with greater facility has led to the construction of powerful instruments, among which is the great meridian circle of the Observatory of Paris. The maps of the heavens and catalogues of stars have through them been made more nearly perfect. Among these the ecliptic maps of MM. Henry deserve special mention. When these astronomers undertook to construct the maps across the milky way they were dismayed by the immensity of the work, and invoked the aid of photography. The remarkable results they obtained have served as the point of departure for the enterprise of the photographic map of the sky. The Astro-Photographic Con-

gress at Paris, in 1887, decided to photograph the whole sky down to stars of the fourteenth magnitude. Could this enterprise have borne all the fruits it has if the planets of the thirteenth magnitude had been let pass unperceived?

For all these reasons, I think that the search for minor planets ought to be continued. It demands, indeed, considerable work in calculation; but that can be divided among several scientific establishments. The Bureau of Longitudes is disposed to do its part in the matter.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

THE NATCHEZ INDIANS.

By HOWARD A. GIDDINGS.

THE Natchez were the ancient head of the demi-civilized people inhabiting that part of America called Florida by the first discoverers. It is evident, from the historians of De Soto's expedition, that a state of society prevailed among this people very different from that of their neighbors. The Natchez can not properly be classed as North American Indians; differing widely from all other tribes in language, customs, and condition, they seemed in most respects like another race. They came originally from Mexico, and closely resembled the Aztecs, both in appearance and habits. Possessing none of the roving disposition common to the savage, their houses, furniture, and domestic implements were comparatively comfortable and convenient. We are told that their houses were gathered together into towns, and resembled farm-houses in Spain, being surrounded with bake-houses, granaries, etc., showing a nation no longer in the hunter state, but attached to the soil, with all the corresponding effects of a life advanced a step toward civilization.

Their houses were nearly always a perfect square. They constructed them by bringing from the woods young trees about fifteen feet in length and four inches in diameter, which they planted in the ground fifteen inches apart, the strongest at the four corners; the tops being bent inward to the center and fastened with split canes. The chinks in the walls were filled up with a mortar of mud mixed with a tufted herb called Spanish beard, leaving no opening but the door. The roof was thatched with turf and straw, and over all was plaited a mat of split canes; the walls were covered both inside and out with mats of the same material. With occasional repairs these buildings lasted twenty years.

The Natchez lived under a despotic government, and it is but

natural that the chiefs were lodged in a manner superior to their subjects. The following description (Garcilaso de la Vega, Historia de la Florida) will apply generally to all the capitals and habitations of the chiefs in Florida:

They always endeavored to place their towns upon elevated sites; but, because such situations are rare in Florida, or on account of difficulty in procuring suitable materials for building, they raised eminences (mounds). Choosing a suitable place, they brought a great quantity of earth, which they raised into a kind of platform, sometimes of a very considerable height, the flat top of which was capable of holding from ten to twenty houses, to lodge the cacique (chief), his family, and suite. The sides of the mound were made so steep that it was impossible to ascend but by steps, or causeways of earth, sloping gradually to the ground. Around the foot they traced a square, conformable to the extent of the town they intended to build, and around this square the more considerable people built their dwellings. The commonalty built around them in the same manner; the whole population thus surrounding their chief.

The house of the cacique was larger and more commodious than the houses of the people, but not otherwise materially different; though a Portuguese gentleman who accompanied De Soto describes the houses of the chiefs in some parts of the present State of Alabama as having had porticoes to their doors.

It is stated that in the dwelling of the Cacique of Palisema the inner apartment was hung with buckskins so well dried and wrought "that one would have taken them for good tapestry, the floor being also covered with the same." The furniture in the dwellings of the Natchez corresponded with their superior construction. They had an equivalent for a bedstead, and also wooden seats or stools, boxes, baskets, and mats of split cane, finely wrought and ornamented.

Their tools, like those of the barbarous tribes, were made of bones, flints, etc., although copper was sometimes used. In the history of De Soto's invasion we read of copper axes or hatchets, pikes with copper heads, staves, clubs, etc., made partly or entirely of copper. They also made "kettles of an extraordinary size, pitchers with small mouths, gallon bottles with long necks, and pots or pitchers for bear oil which would hold forty pints." They made salt from the water of saline springs near the mouth of the Arkansas River, evaporating it in earthen pans made for the purpose, which left the salt formed into square cakes. Their dress was much like that of the ruder tribes, which, however, they surpassed in the manufacture of clothing from wild hemp, mulberry bark, and feathers. McCulloh states that fans made from feathers were used by the Natchez nobility.

They cultivated maize, beans of several kinds, the large sunflower, sweet potatoes, melons, and pumpkins. Bartram found around the ancient monuments of Georgia and Alabama fruit trees, supposed to have been planted by the Natchez. Among them were persimmon, honey locust, Chickasaw plum, mulberry, black walnut, and shell-bark. On one occasion De Soto's troops came upon a pot of honey, "though neither before nor after did they see bees or honey."

The language of the Natchez was easy in pronunciation and expressive in terms—that of the nobles being slightly different from that of the people. For instance, in greeting a noble, one would say "*apapegonaicke*," which is equivalent to "good morning"; while to express the same thing to one of the people, we would say "*tachte-cabanacte*." To request a noble to be seated we would say "*cabam*," while to a common person we would say "*petchi*." The two languages are nearly the same in all other respects, the difference in expression seeming only to take place in matters relating to the persons of the Suns and nobles, in distinction from those of the people.

The Natchez were celebrated for their feasts and festivals. They began their year in the month of March, as was the practice for a long time in Europe, and divided it into thirteen months or moons. At the beginning of each moon they held a grand festival, which took its name and character from that of the moon. The first moon was called Deer, the second Strawberry, the third Small Corn, the fourth Watermelons, the fifth Fishes, the sixth Mulberries, the seventh Maize, the eighth Turkeys, the ninth Buffalo, the tenth Bears, the eleventh, which corresponds to our January, was called the Cold-meal Moon, the twelfth Chestnuts, and the thirteenth Walnuts, these nuts being ground up and mixed with their food at this season of the year.

The Natchez nation consisted of numerous villages, each of which was governed by its own Sun, or chief, all of whom admitted their inferiority to one great chief, who was considered the head of the nation, and was called the Great Sun. Herriot (History of Canada) graphically describes the dwelling and etiquette of the *levées* of the Great Sun: "The cabin of the Great Sun contained several beds on the left of the entrance; on the right hand was the bed of the Great Sun, adorned with different painted figures. This bed consisted only of a paillasse made from canes and reeds, with a square piece of wood for a pillow. In the center of the cabin was a small boundary, around which any one who entered the apartment was obliged to perform the circuit before he was permitted to approach the bed. Those who entered saluted with a kind of howl, and advanced to the extremity of the cabin, without casting their eyes toward the side where the Great

Sun was seated. They afterward gave a second salute by lifting their arms above their heads and howling three times. If they were persons whom the Great Sun respected, he answered by a faint sigh and made them a sign to be seated; he was thanked for his courtesy by a new howl, and at every question the Sun made they howled once before returning an answer. When they took their leave they drew out one continued howl until they retired from his presence."

From the history of De Soto's invasion it is evident that not only the Great Sun, but all the caciques of Florida, were attended with some rude state. The chief of Cosa, when he visited De Soto, was carried in a litter, wearing on his head a diadem made of feathers, while around him attendants "sang and played upon instruments."

The government of the Natchez is what especially distinguished them from the other tribes of North America. Du Pratz says: "The authority which their princes exercise over them is absolutely despotic, and can be compared to nothing but that of the first Ottoman emperors. Like them, the Great Sun is absolute master of the lives and estates of his subjects, which he disposes of at pleasure," etc. As soon as the presumptive heir of the Great Sun was born, every family in which there was a child at the breast gave that child for his service. When the chief died, all these individuals were put to death, to serve their master in the world of spirits.

The Natchez were divided into nobles and common people, which last, with an arrogance not peculiar to savages alone, were designated "stinkards."

The nobles themselves were divided into Suns, nobles, and men of rank. The Suns, according to tradition, were descended from a man and woman who came down from the sun to teach them how to live and govern themselves. They enjoyed immunity from punishment by death, and their nobility was transmitted only through the female line. Although the children, both male and female, bore the name of Suns, the males enjoyed this honor in their own persons alone. Their male children were only nobles; the next generation were men of rank, and the third lowered them to plain stinkards, although distinguished actions might retard the deterioration of the blood. But the case was very different with the female posterity. They enjoyed through all generations the privileges of their rank. Laudonière speaks of a queen "who was much reverenced by her subjects when he visited Florida."

The nobility never intermarried. As we have already noticed, one of their laws prohibited their being put to death for any reason whatsoever. Another law decreed that when a Sun died, his

or her conjugal partner should be put to death at the time of burial. To fulfill these two laws they only married stinkards.

McCulloh states that the Natchez believed mankind to be immortal, and that after death their souls went to reside in another world where they would be rewarded or punished according to their present life. They believed that such as had been faithful observers of the laws were to be conducted to a region of happiness, where their days would pass in pleasure, in the midst of feasts, of dances, and of women; but they believed that the transgressors would be cast on lands unfertile and marshy which would produce no grain. There they would be exposed naked to mosquitoes, and they never should eat but of the flesh of alligators and the worst kinds of fish.

The sun was the principal object of their veneration, and to its honor a perpetual fire was maintained in their temples. The Great Sun, supposed to be the brother of the sun, honored the appearance of his elder brother every morning by a repeated howling, and, having had his pipe lighted, he offered him the first three mouthfuls of smoke, after which he raised his hands above his head and turned from east to west, the course the sun would follow during the day. The temples of the Natchez, like the abodes of the Suns, were built upon mounds erected for the purpose. They were usually about thirty feet square and built of the heart of the cypress tree, which was supposed to be incorruptible.

Du Pratz, who lived among them eight years, relates from their traditions the following history of the institution of the perpetual fire so religiously preserved: The original Sun told them that, "in order to preserve the excellent precepts he had given them, it was necessary to build a temple into which it would be lawful for none but those of royal blood to enter to speak to the Spirit; that in the temple they should eternally preserve a fire which he would bring down from the sun, from whence he himself had descended; that the wood with which the fire was supplied should be pure wood and without bark; that eight wise men of the nation should be chosen to guard the fire night and day; and that if any of them neglected their duties they should be put to death," etc.

Though oral traditions are considered to be of little authority, and are materially perplexed in being handed down from one generation to another, we can still admit that these accounts were originally true. The historical tradition of the Natchez was this: "Before we came into this land, we lived yonder, under the sun" (here the relator pointed nearly southwest, toward Mexico). "We lived in a fine country, where the earth is always pleasant; there our Suns had their abode, and our nation maintained itself for a

long time against the ancients of the country, who conquered some of our villages in the plains, but never could force us from the mountains. Our nation extended itself along the great water, where the large river loses itself; but, as our enemies were become very numerous and very wicked, our Suns sent some of their subjects, who lived near this river, to examine whether we could retire into the country through which it flowed. The country on the east side of the river being found extremely pleasant, the Great Sun, upon the return of those who had examined it, ordered all his subjects who lived in the plains, and who still defended themselves against the ancients of the country, to remove into this land; here to build a temple, and to there preserve the eternal fire. A great part of our nation accordingly settled here, where they lived in peace and abundance for several generations. The Great Sun and those who remained with him were tempted to continue where they were, by the pleasantness of the country, which was very warm, and by the weakness of their enemies, who had fallen into civil dissensions, etc. It was not till after many generations that the Great Sun came and joined us in this country, and reported that warriors of fire, who made the earth to tremble, had arrived in our old country. and, having entered into an alliance with our brethren, conquered our ancient enemies; but attempting afterward to make slaves of our Suns, they, rather than submit to them, left our brethren, who refused to follow them, and came hither attended only by their own slaves."

Their tradition also says that after their removal to Louisiana their nation in the height of their prosperity extended from the river Manchac, or Iberville, to the Ohio, or about four hundred leagues; and that they had about five hundred Suns or princes to rule over them.

At the time we become acquainted with the Natchez their nation was nearly destroyed, though from what causes we do not exactly know. They were expelled from the country originally known as Florida about A. D. 1730, a part being driven across the Mississippi, and the remainder incorporating themselves with the Chickasaws and other neighboring tribes; the new confederacy of the Creeks arising upon their ruins. It is probable that their final downfall was caused by De Soto's ferocious and bloody invasion, during which for three years their country was ravaged with fire and sword, and the inevitable consequence of which was an inability to defend themselves against the hostile tribes around them, who probably broke into their country from all directions, and smothered the partial civilization which once distinguished this part of the United States.

SURVIVALS FROM MARRIAGE BY CAPTURE.

By Lieutenant-Colonel A. B. ELLIS.

AMONG those races of man which have made the least progress in civilization we find that the men of a group or community are in the habit of procuring wives by seizing and carrying off the women of other groups or communities. It is the practice, for instance, among the Fuegians, the Australians, the tribes of the Amazon, some of the aborigines of the Deccan, several of the Malay peoples of the Indian Archipelago, many African tribes, and other peoples too numerous to be here given in detail. Shortly summarized, it may be said that the practice is caused by the scarcity of women, which results from female infanticide, which in its turn is due to the struggle for existence, necessarily hard among savage races who trust wholly to the chase and the spontaneous fruits of the earth for their supply of food. Wherever man lives under such precarious conditions each extra mouth to fill becomes a matter for serious consideration, and as male infants, future hunters and braves, are of more value to the group than female, the latter are slain in a larger proportion. As man emerges from these conditions and cultivates the soil or domesticates animals, the struggle for existence becomes less hard, infanticide diminishes, and the sexes become more equally balanced. But the former condition lasts long. It is probably within the mark to say that several centuries passed away before man commenced to till the soil, and many more before he began to domesticate animals; and during the whole of this time, to judge the past by the present, he probably obtained wives by capture from his neighbors.

Now, after man had for a great number of generations been in the habit of associating marriage with a violent abduction of women, he would inevitably come to regard the two as necessary complements of each other. Man is a creature of habit, and continually perseveres in old customs when their necessity has long passed away, and when even their meaning and intention have been forgotten. Hence, as he has been in the habit of seizing women for wives, he would, even when the necessity for violence no longer existed, still continue to preserve at least the form of it; regarding the acquisition of a wife without some semblance of force as improper, because unusual, and at variance with old custom. As time passed on, this form, or rite, of capture would necessarily become disintegrated, passing from an actual capture to a symbolic capture, and finally dwindling away into a variety of minor ceremonies. These, which we may call forms of survival

from marriage by capture, it is the purpose of this paper to classify. They are numerous, examples being forthcoming from every part of the world, and from peoples in every phase of civilization. This, however, is as might be expected, for it is certain that almost every race of man must have passed through the initial stages which gave rise to the practice. The marriage by capture *de facto*, it must be observed, is a violent abduction, regarded as an act of hostility. With this class it is not proposed to deal. The hostile abduction is the actuality; and what we are now about to inquire into are the ceremonial abductions, and practices derived therefrom, the symbols of the former reality.

The different forms of survival so blend one into another, and two are so frequently found combined together, that it is impossible to make a classification that will meet every case; but what it is here proposed to do is to group the forms under general heads, from which the more disintegrated varieties may be traced. For this purpose it will be convenient to divide them into two groups, viz.: (1) Forms which precede the consummation of the marriage; (2) forms which follow it. These two groups may again be divided, the first into (*a*) forms symbolizing a conflict between opposing parties or clans; (*b*) forms symbolizing a capture of a woman, either by a party or by an individual; and (*c*) bride-racing; and the second into (*d*) forms symbolizing an escape or attempt to escape from the husband; and (*e*) forms limiting social intercourse between the young couple and their relatives by marriage.

The form which approaches nearest to the reality, and which is therefore probably the most archaic, is that in which the bridegroom, assisted by his friends, attempts to seize and carry off the bride, the seizure being resisted by her friends. There is a good deal of violence, and the bridegroom is not always successful. We find a good example of this form in Captain Johnstone's Maoria.* Among the New Zealanders an indispensable preliminary to every description of *tawa*, or expedition—whether a *tawa muru*, a *tawa* to confiscate, a *tawa tango*, a *tawa* for carrying off a woman, or a *tawa toto*, a *tawa* to kill or destroy—was to send and give notice, otherwise it would have been stigmatized as a *koharu*, a murder, or act of treachery. The notice once given, the march of the raiding party might follow immediately, or be delayed for an indefinite time, which was sometimes done with the view of throwing the enemy off his guard. In the *tawa tango* described by Captain Johnstone, a young man of the Ngatiroa tribe had fallen in love with a girl of the Mania tribe, and, as there was no reason to hope that a demand for the hand of the

* Pp. 126 *et seq.*

lady would prove successful, the chief of the Ngatiroa was induced, through the influence of a new wife, the sister of the suitor, to proclaim a *tawa tango*. An ambassadress was sent to give notice to the Mania tribe, and two large canoes full of men accompanied her. The ambassadress saw the *tawa* received at a friendly village, where it was arranged it should remain for a day or two, and then went on to the settlement of the Mania. There she was received with great respect and distinction, nor was there the slightest change made in the manner of her hosts when she announced that a *tawa* would arrive the next day or the day after to carry off a certain maiden. "Of whom did the *tawa* consist?" she was asked; and when the Mania learned that it was only composed of about one hundred and sixty men in two canoes, they felt rather offended at so small a *tawa* coming to attempt the abduction of one of their maidens. However, in the mean time, and without the knowledge of the ambassadress, who would have been obliged by custom to declare the true strength of the party, the *tawa* had been re-enforced by seven more canoes full of men, which had started a few hours after the first two. The warriors in these canoes reached the Mania settlement and hid in a gully close below the *pa*, or stockaded fort, leaving the two original canoes to approach alone. When the Mania saw only these two canoes, they opened the gates of their *pa*, and the chiefs, having marshaled their men, performed the customary dance of welcome. The Ngatiroa who had landed below the *pa*, formed in a long, oblong phalanx, the rear of which rested upon the gully in which their friends lay concealed, and, upon the conclusion of the dance of the Mania, commenced their share in the performance. The oblong wedge, the Maori order of battle, advanced singing in a low tone, and gesticulating in what they would have called a mild manner. On they advanced, the movement raising no suspicion in the breasts of their adversaries, it being part of the customary ritual of the war-dance, until the thin end of the phalanx overlapped the Mania, and stood between them and the gates of the *pa*. Suddenly a change was visible in the antics of the Ngatiroa; their gesticulations became violent, their eyes protruded, their heads were thrown back, and their throats uttered a mighty shout. As the cry passed their lips, a stream of warriors rushed up the banks of the gully and joined the cluster of their comrades, now swollen to a compact mass of six hundred men. When the Mania realized the ruse practiced upon them, they never for a moment thought of giving up the fair cause of the incursion without a struggle. Into the *pa* poured both parties—the Mania to rally round the girl; the Ngatiroa, except the small party expressly told off to carry away the lady, seeking every man an opponent to wrestle with. Each

party was anxious to avoid bloodshed, both being "Tribes of the River." The uproar was therefore greater than had they been engaged in actual warfare, it being more difficult to master a man by strength of muscle than to knock a hole through him. At length superior numbers prevailed. Those who fought around the lady were dragged away; she was roughly seized, and such a tugging and hauling ensued that, had she not been to the manner born, she must have been rent in pieces. At last but one young man, a secret admirer of the lady, retained his hold. An active young fellow, he had so twisted his hands and arms into the girl's hair, and fought so vigorously with his legs, that he could not be removed until he was knocked down senseless. The contest ended, and the bride being borne in triumph to the canoes, both parties proceeded to pick up their weapons and smooth their feathers. Everything had been conducted in the most honorable and satisfactory manner. The Ngatiroa had duly declared their intention, and, if they had surprised the Mania, the latter had learned a lesson, and had only succumbed to superior numbers. No lives had been lost; only a few bones broken, which would soon mend, and it would be their turn next time. In the mean time their own characters required them to fulfill the duties of hospitality, and the *tawa* was requested to remain until food was cooked and placed before it,

The Wa Kamba (Africa) observe a form of capture very similar to the foregoing. Among them the bridegroom is required to carry off his bride by force after the preliminaries are completed. This is attempted by the help of all the friends and relatives that the man can muster, and resisted by the friends and relatives of the woman, and the conflict now and then terminates in the discomfiture of the unlucky husband, who is reduced to the necessity of waylaying his wife when she may be alone in the fields or fetching water from the well.

In these examples resistance is offered by both the men and women of the bride's party, even to the extent of causing a failure of the marriage, at all events for a time. The first disintegration, therefore, appears to be when such resistance is still offered, but where, if it be successful, the bride is finally produced and given up to the party of the bridegroom.

This form is observed by the Kookies of the northeastern frontier of India, of whom Colonel McCulloch says: "When they go to bring away the bride, after having paid for her, they usually receive more kicks than halfpence from the village—that is, they usually get well beaten. But, after the fight is over, the woman is quietly brought from her home and given to the party that came for her, outside the village gate." The custom of the Karens (Burmah), mentioned by Sir John Bowring, is a survival,

in a disintegrated condition, of this or of the foregoing form. He says, "A candidate for the hand of a virgin must escalade her cabin, and is expected to overthrow a strong man placed in her defense."* A still more disintegrated form is found in Turkey, where the bridegroom is chased by the guests, who slap him on the back and pelt him with their slippers. A curious variation of this ceremony survives among the Arab tribes of Upper Egypt, where, at the marriage feast, "the unfortunate bridegroom undergoes the ordeal of whipping by the relations of his bride." Sometimes the punishment is exceedingly severe, it being administered with a whip of hippopotamus-hide; but, if the bridegroom wishes to be considered a man of gallantry, he must receive the chastisement with an expression of enjoyment. After the flogging, the bride is led to the bridegroom's residence.†

The next disintegration appears in those cases in which resistance is offered only by the women of the bride's party, the men remaining passive. This form prevails among the Khonds in the hill tracts of Orissa (India). The bridegroom, assisted by a party of twenty or thirty young men, carries off the bride, in spite of the desperate attacks of her female friends, who hurl stones and bamboos at the head of the devoted bridegroom, until he reaches the confines of his own village. The same form is observed by the Kolams of the Pindi Hills (India), by the Mosquito Indians (Central America), and by the Eskimos of Cape York. A variation is found in the kingdom of Futa, Senegal, West Africa, where the bridegroom and party come to the house of the bride by night and endeavor to carry her off. In this they are resisted by all the girls of the village. A very disintegrated form of this variety seems to have been in vogue at royal marriages in Ceylon. Dr. Davy tells us that the king and queen threw perfumed balls and squirted scented water at each other. In this the *wives* of the chiefs took part, and were at liberty to pelt and bespatter even royalty itself as much as they pleased.‡

We pass now from cases in which actual violence is offered to those in which violence is merely simulated. The first of these is that in which there is a sham fight between the opposing parties. This form is very widely distributed. Colonel Dalton mentions that, among the Kols of central India, when the price of a girl has been arranged, the bridegroom and a large party of his friends of both sexes enter with much singing and dancing and sham fighting into the village of the bride, where they meet the bride's party, and are hospitably entertained.* The Malays of the Strait

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* Kingdom and People of Siam, vol. ii, p. 45.

† Sir S. Baker, Nile Tributaries of Abyssinia, p. 125.

‡ Account of Ceylon, p. 166.

* Ethnology of Bengal.

of Macassar have first a sham fight outside the town, then a feigned resistance at the gates, and afterward, from point to point, a show of disputing the advance of the bridegroom and his party, until they have made their way to the bride's house.* In Abyssinia, the party of the bridegroom go through a sham fight outside the bride's house, then enter it, and the bridegroom, taking the bride, hurries her out and hands her over to some of his friends. Returning to the house again, he then takes part in the *deball*, or war-dance, which is a simulated combat with guns, spears, and swords, and in which the parties of the bridegroom and bride are ranged on opposite sides.† "In New Zealand," says the Rev. R. Taylor,‡ "even in the case when all were agreeable, it was still customary for the bridegroom to go with a party, and appear to take her away by force, her friends yielding her up after a feigned struggle." In Berry, France, the house of the bride is barricaded, and a sham assault of it takes place. After some parley the bridegroom's party is admitted, and a struggle for the possession of the hearth is then simulated. In Little Russia, in peasant weddings, when the bride's tresses have been unplaited and the cap is being put on her head, she is bound to resist with all her might, and even to fling her cap angrily on the ground. Then the groomsmen, at the cry of "Boyars to your swords!" pretend to seize their knives and make a dash at the bride, who is thereupon surrounded by her friends, who come rushing as if to her rescue.*

It is interesting to note that this form survived among the Celtic inhabitants of the British Isles until very recent times. Lord Kames describes it as it existed in his day among the Welsh, as follows: "On the morning of the wedding-day the bridegroom, accompanied by his friends on horseback, demands the bride. Her friends, who are likewise on horseback, give a positive refusal, on which a mock scuffle ensues. The bride, mounted behind her nearest kinsman, is carried off, and is pursued by the bridegroom and his friends with loud shouts. It is not uncommon on such an occasion to see two or three hundred sturdy Cambro-Britons riding at full speed, crossing and jostling, to the no small amusement of the spectators. When they have fatigued themselves and their horses, the bridegroom is suffered to overtake the bride. He leads her away in triumph, and the scene is concluded with feasting and festivity." ‖ Sir Henry Piers's description of it, as observed by the Irish, is: "On the day of bringing home, the bridegroom and his friends ride out and meet

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* Moore's Marriage Customs, p. 196.
† Life in Abyssinia, p. 51.
‡ Te Ska Amani, p. 163.
* Ralston's Songs of the Russian People, pp. 284, 285.
‖ History of Man, p. 449.

the bride and her friends at the place of meeting. Being come near each other, the custom was of old to cast short darts at the company that attended the bride, but at such a distance that seldom any hurt ensued. Yet it is not out of the memory of man that the Lord of Hoath on such an occasion lost an eye. The custom of casting darts is now obsolete."* Among the Highlanders of Scotland it was the custom for the parties of the bride and bridegroom to go in procession to a point of meeting midway between their dwellings, and, when they came near each other, to fire volleys at one another from pistols and muskets.

The next disintegration seems to be found in those cases in which all show of resistance to the party of the bridegroom is limited to closing the house against it. Several varieties of this form occur among the southern Slavs. In Croatia, the bride and her friends being assembled, all the doors of the house are closed to prevent a surprise by the bridegroom's party. The assembled guests are on the alert, and, as soon as they hear the party approaching, all the lights are put out and all keep silence. The visitors knock repeatedly without getting any answer, but at length they advance various pretexts to get admission, and at last, after a long parley, are admitted. In Dalmatia and Bulgaria the door is similarly closed against the bridegroom's party, and admission only obtained on payment. In Transylvania the doors are closed, and the bridegroom must, as best he can, climb over into the court, open the door from within, and admit his companions.

We now come to those forms in which no resistance, either real or feigned, is offered by the party of the bride, who merely simulate grief or terror, and it is the party of the bridegroom alone which makes a show of violence. This was the form observed by the Romans in plebeian marriages, and a full description of it is given in the Golden Ass of Apuleius, in the story of the Captive Damsel, where the bride, describing how she was carried off, says that a band of men, armed with swords, rushed in, and, without meeting with any resistance from the inmates, tore her from her mother. The Circassians have the same ceremony, it being the custom to give a feast, in the midst of which the bridegroom rushes in and, with the help of some companions, carries off the bride by force. This form, in a very disintegrated condition, is found in the isle of Skye and the west Highlands of Scotland, in the ceremony known as "stealing the bride." It occurs in the middle of a reel. The groomsman and bridesmaid slip into the place in the dance of the bridegroom and bride, while the bridegroom suddenly jerks the bride out of the room.

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* Description of Westmeath.

The foregoing are the general types of the forms of survival in which the party of the bride is represented. We have traced the various stages of disintegration from actual resistance offered by both the men and women of the bride's party, to the offering of such resistance terminated by a surrender of the bride, and then to resistance being offered by the women only. Thence, from feigned resistance evinced by a sham fight, it passed to the mere closing of the house, and finally to the form in which no resistance is simulated. The semblance of hostility to the party of the bride gradually dwindles away till it is reduced to merely tapping the father and mother of the bride on the shoulder with a small stick, as is done by the Samoyeds, or to the pretense of tearing the bride from the arms of her mother, as is the custom in Sardinia. To come down to ourselves, it is very probable that the practice of throwing an old shoe after the departing bride and bridegroom is a last surviving relic of the form of a struggle between opposing parties.

It is difficult to say to what class such ceremonies as that observed by the Mundaris of Bengal, where an arrow is fired through the loophole formed by the arm of the bride as she holds a pitcher of water on her head, and by the Romans, where the bride's hair was parted with a spear, belong; but the use of weapons seems to justify us in regarding them as very disintegrated survivals of our subhead (*a*). Perhaps the custom observed in Anglo-Saxon marriages, where the father delivered the bride's shoe to the bridegroom, and the latter tapped her on the head with it, is also one.

We come now to our subhead (*b*). The forms of capture of this class seem to be symbolic of a capture of a woman by surprise or stratagem. In these, though the bride is carried off with real or pretended violence, her friends offer no opposition and feign no grief. It is no longer a struggle between clans, and there is no longer a party supporting the bride.

First of this class is that form in which the girl is carried off *nolens volens*. The consent of the parents to the marriage has been obtained, and all the preliminaries settled, but in most cases the girl has received no warning of what is about to take place. Sometimes, of course, she may have received a hint, but in this form she is not necessarily a consenting party, and her resistance is violent. Among some peoples it is usual for the bridegroom to be assisted by one or two friends; among others he carries out the abduction alone. The first represents capture by a war party, the second by an individual, but the latter form is comparatively rare.

Of cases in which the bridegroom is assisted by his companions we find examples—1. Among the Mandingo tribes settled along

the banks of the river Gambia, in West Africa, where, after the "head" or purchase money has been paid to the parents, the bridegroom, aided by two or three friends, seizes the girl while she is engaged in her ordinary domestic vocations, and, in spite of her frantic struggles, carries her off. 2. Among the Bedouin Arabs of the Sinai Peninsula, where, after all the arrangements have been made with the parents, the bridegroom, assisted by two friends, seizes and carries off the bride. "If she entertains any suspicion of their designs," says Burckhardt, "she defends herself with stones, and often inflicts wounds on the young men, even though she does not dislike the lover; for, according to custom, the more she struggles, bites, kicks, cries, and strikes, the more she is applauded ever after by her own companions."* 3. Among the Indians of the Amazon Valley, of whom Wallace says: "When a young man wishes to have the daughter of another Indian, his father sends a message to say he will come, with his son and relations, to visit him. The girl's father guesses what it is for, and, if he is agreeable, makes preparations for a grand festival. This lasts, perhaps, two or three days, when the bridegroom's party suddenly seize the bride and hurry her off to their canoes. No attempt is made to prevent them, and she is then considered as married."† Of cases in which the bridegroom is unaided we have an example among the Fijians, with whom it is clear that the consent of the girl is not first obtained, for, says Mr. Williams, "on reaching the home of her abductor, should she not approve of the match, she runs to some one who can protect her; if, however, she is satisfied, the matter is settled forthwith."‡

The first disintegration of this form is seemingly when the bride is a consenting party, knows well enough what is about to take place, and merely offers a feigned resistance. This appears to be the form observed by the southern tribes of Tierra del Fuego, where, according to Captain Fitzroy,* the youth, having obtained the consent of the girl's relations, and having provided himself with a canoe, watches an opportunity and carries off the bride. If she is unwilling, she hides herself in the woods until her admirer is heartily tired of looking for her and gives up the pursuit. The Spartans also observed this form. In most cases the bride is carried to the house of the bridegroom, but among the Indians in the neighborhood of Concepcion, the bridegroom carries off the bride to the woods, the happy pair returning home after a day or two. Among the Tangutans (Mongolia) *wives* may be abducted. Lieutenant-Colonel Prejevalsky says: "They

* Notes, vol. i, p. 263. † Travels on the Amazon, p. 497. ‡ Fiji and the Fijians, p. 174.
* Voyages of the Adventure and Beagle, vol. ii, p. 182.

have a curious custom of stealing their neighbors' wives, of course not without their secret assent. In such cases the stolen wife belongs to her ravisher, who pays the husband a good sum as compensation."*

The next disintegration is, perhaps, to be found in those cases in which the women seize the bride and drag her to her suitor's house. This form occurs among the Greenlanders.

The next is where the violence, or feigned violence, takes the form of tearing the bride's clothes. This form is found among the Tunguses and Kamchadales, of whom Ernan says a matrimonial engagement is not considered as definitely concluded till the lover has got the better of his bride "and has torn her clothes."† A variety of this form is found in Circassia, where an important part of the marriage ceremony consists in the bridegroom drawing his dagger and cutting open the bride's corset.

The next is where the appearance of violence is still further eliminated, and custom only requires the bridegroom to carry his bride to his house. This form is observed by the Indians of Canada, where the bridegroom takes his wife on his back, and, amid the plaudits of the spectators, carries her to his tent.‡ The Western tribes of North America "regard it as an important part of the marriage ceremony that the bride should be carried to her husband's dwelling. In Mexico, also, the husband took the bride on his back and carried her a short distance. Bruce, in Abyssinia, observed an identical custom."* Speke witnessed a similar ceremony at Karague, East Africa, and this form is also observed by the Susus, West Africa, with whom, however, the bride is sometimes carried on the back of a woman.

From carrying the bride on the back, to simply lifting or forcing her over the threshold of the bridegroom's house, the transition is easy. In the patrician marriages of the Romans the bridegroom had to carry the bride over the threshold of the house, and among the Bedouin Arabs it is necessary for the bridegroom to force the bride to enter his tent. A similar custom existed among the French, at least in some provinces, in the seventeenth century. At Sparta, after the actual carrying off of the bride had fallen into desuetude, the bridegroom had to take up the bride and carry her from one room to another. In China, before the bridal procession starts, the young sisters and female friends of the bride come and weep with her till it is time to leave the house of her parents; and when the procession reaches the bridegroom's house the bride is carried into the house by a matron, and lifted over a pan of charcoal at the door. A variation of this

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* Mongolia, vol. ii, p. 121.
† Siberia, vol. ii, p. 442.
‡ Carver's Travels, p. 274.
* Origin of Civilization, p. 88.

form is found in North Friesland, where a young man, called the bride-lifter, lifts the bride upon the wagon in which the married couple are to travel to their house. The last stage is reached in the form seen by Denham at Sockna, North Africa. The bride is taken on a camel to the bridegroom's house, and, upon arriving there, "it is necessary for her to appear greatly surprised, and refuse to dismount; the women scream, the men shout, and she is at length persuaded to enter."*

Finally, an affectation of grief on the part of the bride is the sole demonstration of a feigned compulsion. Such a case was witnessed by Mrs. Atkinson, in Siberia.† It is there the custom for the bride to be taken to the bath on the eve of her wedding-day by her young companions, and in this case the road to the bath led past the house where Mrs. Atkinson was stopping. Startled by most heart-rending sobs, that lady hastened to the gate and found a bride being supported by her young friends to the bath. She thought it was a case in which a girl had been forced to accept an unwelcome suitor, and was filled with compassion. When the girl returned from the bath she was still sobbing and quite bowed down with grief. An hour or two later, Mrs. Atkinson went to the bride's cottage and found the damsel eating supper, her face radiant with joy. She asked if she had *done it well*, and Mrs. Atkinson then learned, to her great surprise, that the weeping was part of the ceremony.

We now come to that form of survival which has been termed "bride-racing," and which we have placed under subhead (*c*). The least disintegrated variety of this form of capture is that in which there is a *bona fide* chase, out of doors, and which does not always end in favor of the lover.

We find this form among the Calmucks, with whom, says Dr. Clarke, the ceremony of marriage is performed on horseback. "A girl is first mounted, who rides off in full speed. Her lover pursues; if he overtakes her she becomes his wife, and the marriage is consummated on the spot; after this she returns with him to his tent. But it sometimes happens that the woman does not wish to marry the person by whom she is pursued; in this case she will not suffer him to overtake her. We were assured that no instance occurs of a Calmuck girl being thus caught, unless she have a partiality to the pursuer."‡ This is slightly varied among the Kirghiz, the young woman, who is pursued by all her suitors, being armed with a formidable whip, which she does not hesitate to use if overtaken by a lover who is disagreeable to her. Among the Turkomans the bride carries in her lap the carcass of a sheep or goat, which the pursuer has to snatch from her. The Malays,

* Travels in Africa, vol. i, p. 39. † Tartar Steppes, pp. 218, 219. ‡ Vol. i, p. 433.

who are eminently an aquatic people, carry out this ceremony on the water. The bride is given a canoe and a double-bladed paddle, and allowed a start of some distance; the suitor, similarly equipped, then follows in chase. If he succeeds in overtaking her, she becomes his wife; if not, the match is broken off.* Among the wild tribes of the Malay Peninsula the chase takes place in the forest, on foot.

The first modification of this form is when the chase takes place in a set race-course, instead of in the open country. This is done by the Malays when there is no stream suitable for the boat-chase near at hand. A circle of a certain size is formed, the damsel, stripped of all but a waistband, is given a start of half the circle, and, if she succeeds in running three times round before her suitor catches her, the marriage is off. Among the Koriaks (northeastern Asia) the race takes place in a large tent, containing numerous separate compartments, called *pologs*, arranged in a continuous circle around its inner circumference; and the girl is clear of the marriage if she can run through the series of *pologs* without being caught. In this case the women of the encampment throw every obstacle in the way of the bridegroom—try to trip him up, and strike him with switches; so that here we have a combination of bride-racing with that form of capture in which resistance is offered by the women of the bride's party. A man has scarcely any chance of succeeding unless the woman wishes it. In a chase witnessed by Mr. Kennan† the bride distanced the lover, but waited for him in the last *polog*.

From this variety the form passes through various stages of disintegration. Among the Aenezes (Arabs) the girl runs from the tent of one friend to another. Here, however, she is caught by the women, and conducted to the tent of the bridegroom, who stands at the entrance and forces her in. Among the Oleepa Indians of California the girl runs away and hides herself. "The lover searches for her, and, should he succeed in finding her twice out of three times, she belongs to him. Should he be unsuccessful, he waits a few weeks and then repeats the performance. If she again elude his search, the matter is decided against him."‡ Among the Ahitas, or Aetas, the Negrito race of the Philippine Islands, the girl is sent away into the forest, by her parents, before sunrise. She has an hour's start, after which the lover goes in search of her. If he finds her before sunset, the marriage is acknowledged; if not, the affair is at an end. Among the Wateita (eastern Africa) the bride hides with distant relatives. Finally, the form becomes merely an elopement of the happy

* Cameron's Malayan India, p. 116. † Tent Life in Siberia.
‡ Bancroft's Native Races of the Pacific States, p. 389.

pair, as among the Soligas (India), where the girl and her lover run away to some neighboring village.

The survivals which follow are in such a disintegrated condition that it is impossible to decide to which class they may properly be referred. It will have been observed that, in all the ceremonies that have been described, the bridegroom is pretended to be regarded as an enemy, a person to be avoided. Hence we can understand the Abyssinian custom described by Mr. Mansfield Parkyns,* who says that, as soon as a young man has become betrothed to a girl, he may not see her face. If he should chance to see her by stealth, she covers her face, screams, runs away, and hides; and this though the greatest intimacy may have prevailed between them before the betrothal. A modification of this custom is found in Ceylon, where, if a young man wishes to see the bride whom his father has selected for him, he must go clandestinely. If he enters the house it must be under a feigned name, and if he sees his intended he must not address her.†

If the bridegroom is to be regarded as hostile to the bride, he must, by a similar fiction, be regarded as hostile to her family also; and hence the many cases in which proposals for marriage must be made through the intervention of third parties, a custom which has neither utility nor convenience to recommend it. Among the Turkomans "the young man does not dare to breathe his wishes to the parents of his beloved, for such is not etiquette, and would be resented as an insult."‡ In Siam marriages are the subject of much negotiation, undertaken not directly by the parents, but by "go-betweens," nominated by those of the proposed bridegroom, who make proposals to the parents of the intended bride.* Davis says the same of the Chinese,‖ and that the two persons principally interested never see each other. In Dahomey it is the custom for a suitor to dispatch two emissaries, a man and a woman, to open negotiations with the family of the girl he wishes to marry. In Samoa, Mr. Pritchard says,^ a man never personally woos his lady-love, and, in the case of a chief, it is the privilege of his attendants to do the courting for him.

These customs are evidently disintegrations of that observed by Caillié in the western Soudan. There, as soon as the suitor has declared himself, he is not allowed to see the father and mother of his future bride. He takes the greatest care to avoid them, and if by chance they perceive him they cover their faces, as if all ties of friendship were broken. The custom extends beyond the relations; for, if the lover is of a different camp, he

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* Life in Abyssinia, vol. ii, p. 41.

† Account of Ceylon, p. 285.

‡ Fraser's Journey, vol. ii, p. 372.

* Bowring, vol. i, p. 118.

‖ Chinese, vol. i, p. 266.

^ Polynesian Reminiscences, p. 134.

avoids all the inhabitants of the lady's camp, except a few intimate friends, whom he is permitted to visit. A little tent is generally set up for him, under which he remains all day, and if he is obliged to come out, or to cross the camp, he covers his face.*

We now pass to the second group of survivals, namely, those which follow the consummation of the marriage. Our first subhead of this group symbolizes an escape, or attempted escape, from the husband.

The least disintegrated example appears to be that which occurs in Zululand, where custom requires that the bride should make three attempts to run back to her old home, but the last attempt, made on the second day, and after she has been installed in her position as wife, is the only serious one. Should she succeed in escaping, the whole marriage ceremony has to be gone through again.†

The first modification of this is when the bride simply returns to her parents' house for a certain time. There is no appearance of flight, but there is a complete rupture of cohabitation. This custom is found among the Ewe-speaking tribes of the Slave Coast (West Africa), the wife, after a week's cohabitation with her husband, returning to her old home for a week. In Chittagong, husband and wife are on no account permitted to sleep together until seven days after marriage.

The next modification is where the bride returns to her former home, but sees her husband by stealth. This form is observed by some of the Turkoman tribes, the bride returning to her father's house, "where, strange to say, she is retained for six months or a year, and sometimes two years, according, as it appears, to her caprice or the parents' will, having no communication with her husband, unless by stealth."‡ According to Plutarch, the Spartans had the same custom, and some husbands even had children by their wives before they could see them otherwise than clandestinely.* Among the Fijians husband and wife do not usually pass the night together, except as it were by stealth; and Lafitau says the same of some of the North American Indians. In Crete it was the custom for married people to see each other clandestinely for some time after the wedding, and a similar custom is said to have existed among the Lycians.

A variation of these forms exists among the Arabs of the Mezeyne tribe (Sinai Peninsula), where the bride runs away to the mountains every evening, being followed by her husband, and returns to her mother's tent every morning. This is done for several days, after which she returns to her mother, and she does not

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* Travels to Timbuctoo, vol. i, p. 94.

† Leslie's Among the Zulus, pp. 116–118.

‡ Fraser's Journey, *loc. cit.*

* Lycurgus, c. 15.

go to live with her husband till she is far advanced in pregnancy. If she does not become pregnant, she may not live in her husband's tent till a full year from the wedding-day.*

Our second subhead of this group comprises those forms in which social intercourse between the husband and the tribe, relations, or parents of the wife is forbidden. He is pretended to be regarded as an enemy who has robbed them of one of their number.

An example of the most complete form of this custom, occurring before marriage, has already been quoted from Caillié, and, apparently, the restrictions remain in force after marriage, at all events for a time. In most cases, however, the restriction is limited to the relations of the bride. This, according to Rochefort,† was the case with the Caribs. He says: "All the women talk with whom they will, but the husband dares not converse with his wife's relatives, except on extraordinary occasions." Baegert describes a similar custom among the Indians of California, with whom the son-in-law was not allowed to look in the face of his mother-in-law, or his wife's nearest relations, but had to step on one side, or to hide himself when they were present.‡ In Florida, the parents-in-law did not enter the son-in-law's house, nor he theirs, nor his brothers-in-law, and, if they met by chance, they went a bow-shot out of their way, with their heads down and eyes fixed on the ground, for they held it a bad thing to see or speak to one another.*

Among other peoples the restriction is limited to the mother-in-law, and this form is very wide-spread. It is, or was, observed by the Indians of North America generally, and by many tribes in South America. In Africa the custom is found among the tribes of the Gold Coast, the Mpongwe of the Gaboon, and the Bushmen. The Zulu and his mother-in-law may not mention one another's names, nor look in one another's faces. If they chance to meet they pretend not to see each other, the man hiding his face with his shield.‖ In Australia "it is compulsory on the mothers-in-law to avoid the sight of their sons-in-law, by making the mothers-in-law take a very circuitous route on all occasions to avoid being seen, and they hide the face and figure with the rug which the female carries with her." The custom which, among the Banyai of South Africa, compels a man to sit with his knees bent in presence of his mother-in-law, and forbids him to put out his feet toward her, has perhaps something to do with this form, as, no doubt, has also the proverbial hostility

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* Burckhardt, vol. i, p. 269.

† Hist. Nat. des Îles Antilles, p. 545.

‡ Smithsonian Reports, 1863–'64, p. 368.

* Tylor, Early History of Mankind, p. 289.

‖ Lubbock, p. 14.

between men and their mothers-in-law of which modern humorists make so much.

That a similar series of prohibitions should exist, limiting the social relations of the wife with the family of her husband, is what we might expect to find; the husband's relatives being of the party of the feigned abductor, and so enemies. Among the Calmucks the daughter-in-law must not speak to her father-in-law, nor sit in his presence. In China, the father-in-law, after the wedding-day, never sees the face of his daughter-in-law again; he never visits her, and, if they chance to meet, he hides himself. With the Ostiaks of Siberia and the Basutos of South Africa the young wife must not look in the face of her father-in-law, and must avoid him as much as possible, till she has borne a child. The Armenian wife must conceal her face from her husband's father and mother. A more archaic form of these varieties is found among the Kaffirs of South Africa, with whom a married woman is cut off from all intercourse, not only with her father-in-law, but with all her husband's male relations in the ascending line. "She is not allowed to pronounce their names, even mentally; and whenever the emphatic syllable of either of their names occurs in any other word, she must avoid it, by either substituting an entirely new word, or at least another syllable in its place."*

This terminates our collection of examples, though we might probably add to those which follow the consummation of the marriage the widely distributed custom which forbids husband and wife to eat together. The numerous cases we have given show how very universal marriage by capture *de facto* must have been, and also, since it has left such enduring traces, for what a long period of time it must have been practiced. Among ourselves it influenced public opinion until comparatively recent times, for it was not until the reign of Henry VII that the violent seizure of a woman was made a criminal offense, and even then the operation of the statute was limited to the abduction of women possessed of lands and goods. A man might still carry off a girl, provided she was not an heiress; but in spite of the law and its severe penalties, the abduction of heiresses continued to be a common occurrence, especially in Ireland, down to the close of the last century, and to be regarded by the general public as but a venial offense at most.

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* Maclean, Compendium of Kaffir Laws and Customs.

THE CHARACTERISTICS OF INSECTS.

By LOUIS MONTILLOT.*

INSECTS, arachnids or spiders, myriapods and crustaceans, are all included in the sub-branch of the arthropods or joint-limbs. Of the characteristics by which they are distinguished we mention here only the most salient. Insects have six legs, arachnids eight, and myriapods a more considerable number, but always short of ten thousand. The legs of crustaceans are variable in number; they have a carapace consisting of the external skeleton, which, being impregnated with carbonate and phosphate of lime, is always consistent and sometimes very hard.

The body of insects is divided into three distinct parts: the head, the thorax, and the abdomen. We may therefore define insects as articulated animals with six legs, having head, thorax, and abdomen distinct.

The life of the insect comprises four successive stages: those of the egg, the larva, the pupa, and the perfect insect. The rule, however, is subject to some interesting exceptions. The reproduction of insects usually takes place through sexual connection. The eggs are fertilized while passing through the oviduct of the female; but the females of certain bees, some of the butterflies, and several aphides, lay fertile eggs without the assistance of the male; this phenomenon is known as parthenogenesis. With some other species the females are viviparous.

The egg is composed of a firm shell, containing a limpid liquid that includes the germ of the embryo and the vitelline globules which are destined to nourish it. The eggs of insects are of the most diversified forms. The shells of many are adorned with remarkable figures. At the moment of hatching, the shell breaks, or rather opens like a hinged box-cover. A large number of the eggs look like seeds. Some are round, others cylindrical, conical, or hemispherical. Others represent solid forms, either flattened or terminating in a point. A curious study is furnished by the art with which the females deposit their eggs. Here we find single eggs; there we see them collected in considerable numbers within a parchment or silken protective envelope, which floats on the water, or is inserted in bark or attached to a stone. At other times we find a chaplet of symmetrical beads, arranged in closed rings around the branch of a tree. To deposit her eggs, the female bores with her ovipositor into the stems of plants, the tissues of animals, or the timbers of our houses. There are no old tree-trunks or cracked walls that may not serve her for a hatch-

* Translated from the book L'Amateur d'Insects. Paris: J. B. Baillière et fils, 1890.

ing place. The female takes care to place her eggs in conditions which will permit her progeny to find food for themselves from birth; but her solicitude usually ends at this point, while she leaves it to the rays of the sun to do the rest—a happy arrangement, for in most cases the parents die before the hatching. The embryo is developed rapidly under the influence of the ambient heat, and in a short time breaks the shell or springs the cover.

From the egg issues a being very little or not at all like its parents. Insects, indeed, undergo, before attaining full development, a series of transformations which are designated as metamorphoses. These metamorphoses are complete or incomplete; and there are even what we might call hypermetamorphoses, as in the case of the cantharides, the evolutional life of which, only recently well understood, is much more complicated than that of most other insects. The metamorphosis is said to be incomplete when the forms of the young insects, on coming out from the egg, are like those of the adult. Insects whose metamorphoses are complete come from the egg in the form of larvæ.

The growth of the insect all takes place during the larval state, and is very rapid. The superficial envelope soon becomes too small for the body it contains. So, at determinate periods of their existence, larvæ change their skin, or, to speak more accurately, burst the integument which envelops them, and shed it. This transformation constitutes the molting, which is repeated from three to eight times, according to the species. During these periods of transition, the larva, as if ill, loses its insatiable appetite, ceases to eat, and becomes stationary.

Insects of incomplete metamorphosis likewise acquire their full development through successive moltings. Each of the moltings is attended by a corresponding perfectionment of some part of the organism.

Larvæ of insects often have a horned head, with jaws that permit them to crush food. This conformation also occurs in the larvæ of insects which in the adult state have the mouth organized for suction. Some larvæ of *Dipteræ*, however, have the fore part of the body terminated by a pointed and retractile appendage; they might be spoken of as acephalous.

After the head come the rings, very like one another, and not exceeding a dozen in number. In these there are three varieties of structure: larvæ having only articulated legs (Fig. 2, upper); those having both articulated and membranous legs; and apodous larvæ, or those having no legs (Fig. 2, lower).

In the first variety the articulated legs, which end in one or two claws, are attached to the three rings immediately following the head, each ring supporting a pair of legs. The same rings form, at a later stage, the thoracic casing of the perfect insect.

In the second variety the articulated legs are six in number. They are, besides, inserted as already described, but the fourth

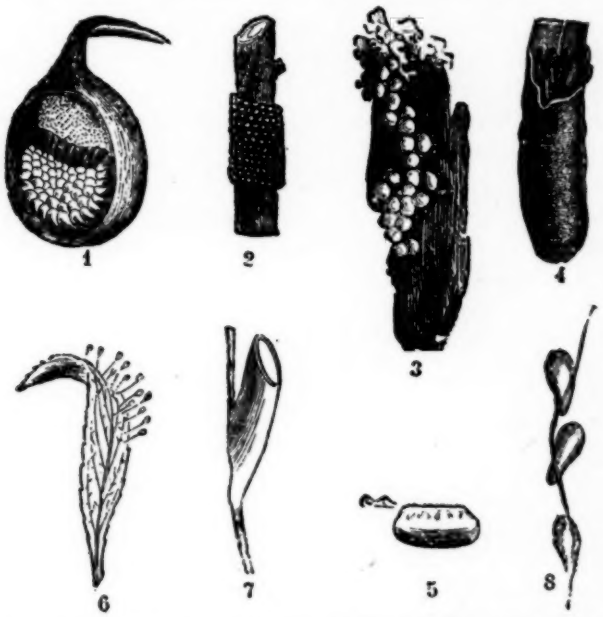


FIG. 1.—EGGS OF INSECTS. 1. Eggs of *Coleoptera* (opened shell of *Hydrophilus piceus*). 2. Eggs of Moths (*Bombyx neustria*). 3. Eggs of Moths (*Lasiocampa pini*). 4. Eggs of *Orthoptera* (*Acridides*). 5. Eggs of *Orthoptera* (*Blatta*). 6. Eggs of *Neuroptera* (*Hemeroba*). 7. Egg of *Diptera* (*Œstrides*). 8. Eggs of Louse.

and following rings are furnished with fleshy protuberances, without articulations, which are designated as membranous legs.

In the third variety, larvæ are regarded as apodous, in which, while they have no articulated legs, the locomotive apparatus is often represented by pads similar to the membranous legs.

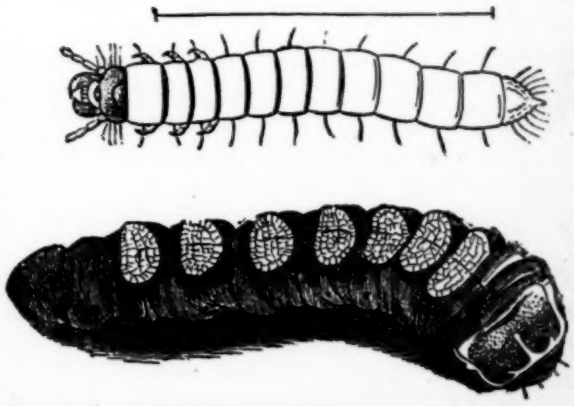


FIG. 2.—LARVA WITH ARTICULATED LEGS, AND APODOUS LARVA.

Some larvæ bear silky tufts, others a sort of spines, and others fleshy appendages of curious forms. Many, like certain caterpillars, wear a brilliant livery, while others present a dull color that offers to the eye only false tones, passing from a dirty white to a

maroon, with some parts—the head, for example—remaining darker.

Larvæ are to be found, we might say, everywhere and in everything—on the leaves and roots and in the interior of plants, under the ground, in putrefying matter, in the tissues of living animals, in cloths, and in water. Wherever they are found, these larvæ are busy, before everything else, in alleviating the hunger of the moment. They devour, and they gorge themselves, without taking any care to protect their existence against aggressors from without. But a more provident minority construct shelters for themselves—little movable houses which the animal carries with itself, and within which it with-

FIG. 3.—LARVA WITH ARTICULATED LEGS AND WITH MEMBRANOUS LEGS.

FIG. 4.—CASES OF PHRYGANIDES.

draws in case of danger, like a turtle in its shell. The larva fixes itself to this refuge by means of its membranous legs, and moves without by its articulated legs. The materials necessary for the construction of the nest are gathered up in the element in which the animal lives. They are twigs, grains of sand, fragments of shells, collected in water by the *Phryganeidæ*, shreds taken from our cloths by the *Tineidæ;* earthy substances by the *Chythra;* and all are glued together by the secretions of the insect.

Whether in the open air or in water, or in the bottoms of underground chambers, larvæ, at a certain period of their evolution, undergo another change, and are transformed into nymphæ. Among the insects of incomplete metamorphosis, the nympha is but little different from the larva, and molts and is fed in the

same way. Insects of complete metamorphosis act very differently: the larva becomes stationary and ceases to take food; the skin becomes like parchment, and slight movements of the abdominal rings, when they are touched, are the only signs of life. Yet, from the beginning of the transformation, on the seemingly half-dead being, appear distinctly, although masked by a thick veil, the antennæ, wings, and legs. These organs are symmetrically folded along the body, and the motionless nympha under the veil presents the forms of the perfect insect. It remains sometimes fastened to a wall or hanging from a branch by one of the silky threads which the larva has woven; in other cases it is enveloped in a firm shell or surrounded by a silken cocoon. Nymphæ thus protected remain in the open air, while others, less well guarded, find shelter from bad weather and the direct force of the sun often by being buried deep in the ground.

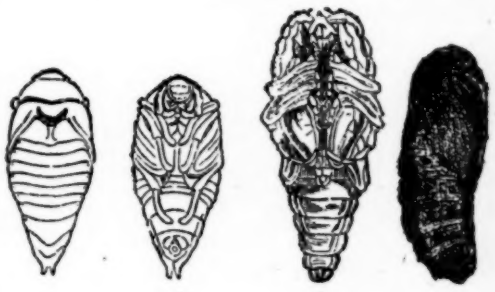


FIG. 5.—1. Nympha of Cockchafer, seen from above. 2. Nympha seen from below. 3. Nympha of Cerambyx. 4. Chrysalis of Bombyx.

The insect secures its release from its nymphal envelope at the expense of violent muscular efforts. Sometimes the envelope splits in the back and gives passage in succession to the thorax, the head, the legs, and the wings; sometimes the hinged lid or operculum which closes the shell gives way under the pushing of the prisoner. At the moment of emerging, the young animal is not able to fly; its wings are crumpled and soft, but the circulation soon becomes more active, the wrinkles vanish, and the wings acquire sufficient consistency to permit the new being to take flight.

As we have already seen, the body of the adult insect may be divided into three principal and distinct parts—the head, the thorax, and the abdomen. The head (Fig. 6) bears the mouth, antennæ, and eyes; the three pieces that follow are the three united rings that constitute the thorax. After the thorax comes the abdomen, the rings of which are movable and capable of gliding upon one another.

The head may be divided into several regions, which it is important to define well. They are, in fact, of great assistance in the description and determination of species. They are four in number: the front, including the space between the eyes; the vertex, or upper part of the head, behind the eyes; the cheeks, below and in front of the eyes; and the *epistoma*, sometimes called

the hood, prolonging the front, and running down in front of the mouth. The head is generally articulated with the prothorax by a fine ligament, which leaves it more or less freedom of motion in all directions.

The mouth of insects is arranged to masticate, lick, or suck food. The buccal parts are of course fitted to their purpose, but the type to which all should be referred is the masticatory apparatus, which, by repeated applications to functions foreign to its

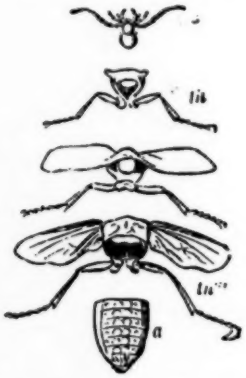


FIG. 6.—PARTS OF WHICH THE BODY OF A COLEOPTER IS COMPOSED. *c*, head; *th'*, first ring of the thorax (prothorax); *th''*, second ring of the thorax (mesothorax); *th'''*, third ring of the thorax (metathorax); *a*, abdomen.

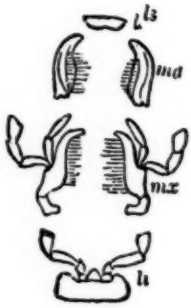


FIG. 7.—MOUTH OF A MASTICATING INSECT. *ls*, labrum; *md*, mandibles; *mx*, jaws and maxillary palpi; *h*, lower lip and labial palpi.

primary destination, has been insensibly modified and at last transformed, according to circumstances, into a licking or sucking apparatus. The buccal organs of masticating insects move laterally, after the manner of scissors, while the jaws of vertebrates work up and down, like pincers.

When we examine the mouth of the masticating insect, we find in it parts in the order indicated in Fig. 7. First is an upper lip, or *labrum*, *ls*; second, a pair of upper jaws, or mandibles, *md*; third, a pair of lower jaws furnished with maxillary palpi, *mx*; and fourth, a pair of labial palpi supported by a lower lip, *h*, which is itself attached to the border of the buccal cavity forming the chin. The articulated mandibles on the cheeks are strong pincers, which sometimes attain a very considerable development. They are often dentated on their inner border.

The lower jaws are composed of several pieces. Their inner lobe is frequently furnished with a brush of silky threads, and sometimes ends in a little mobile tooth, such as may be remarked among the *Cicindelæ* (*Coleoptera*). The outer lobe is often articulated in the same way as the palpi. The insect may then be regarded as having two pairs of maxillary palpi.

The maxillary palpi include from one to six pieces or joints. The labial palpi have from two to four. The intermediate piece, or tongue, is subject to great modifications. With the chin, it completes the buccal pieces.

In the licking and sucking insects the organs we have described are adapted to their new functions. Thus the tongue in bees reaches a great development; bugs, grasshoppers (Fig. 9), and lice have a long beak enveloping silky hairs, which form rudiments of jaws; in the butterflies we perceive a dispropor-

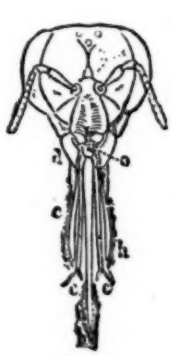


Fig. 8.

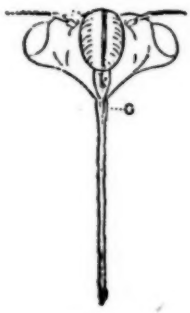


Fig. 9.

Fig. 10.

Fig. 8.—Mouth of a Bee. *b*, tongue; *c c*, labial palpi; *d*, mandibles; *e*, jaws; *h*, inner lobe; *o*, upper lip, or labrum.

Fig. 9.—Beak of a Grasshopper.

Fig. 10.—Trunk of a Butterfly.

tionately long proboscis; while in the *Diptera* the dispositions vary with the different groups. But in all these transformations the attentive observer will be able to perceive vestiges of the pieces comprising the mouth of the masticating insect which we have chosen as a type. These homologies were clearly established by De Savigny in 1816.

The eye and the head in vertebrates are movable. The visual rays consequently embrace a large horizon. The eye of the insect, on the contrary, is immovable, and solidly incased in the head; and the movements of the head itself are very limited. A great inferiority would result from this, had not Nature compensated for it by augmenting the circle of action of the eye itself. The insect's eye is formed by the union into a single mass of a considerable number of little eyes—sometimes exceeding twenty thousand (Fig. 11). Each of these minute organs, which are easily distinguished with a glass, comprises a hexagonal facet, representing the cornea; below this, a conical refracting mass represents the crystalline lens, and upon this abuts the nervous net emerging from the ganglion, which is itself in relation with the cerebral mass. The apparent part of the eyes is rounded, like a spherical cap, or rather like a portion of an ellipsoid. Sometimes the inner

edge is indented like a bean, or like the kidneys of vertebrates. The eyes are then said to be reniform.

The organ of vision is sometimes made more complete by simple eyes, detached from the general group and permitting the insect to distinguish parts of space outside the field of the faceted eyes. These supplementary organs, called *ocelli*, usually three in number, are arranged triangularly between the reticulated eyes.

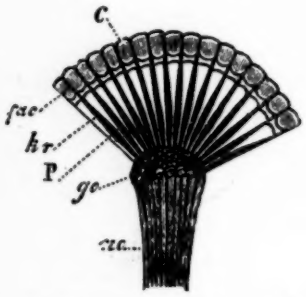


FIG. 11.—SECTION OF AN INSECT'S EYE. *C*, cornea; *fac*, cones; *hr*, rods; *P*, pigmentary sheathings of the rods; *go*, ganglion of the optic nerve; *no*, optic nerve. (According to Nuhn.)

The antennæ are articulated appendages which insects bear on the head, near the eyes, sometimes forward of them, sometimes behind them, and which are often greatly developed.

The antennæ are generally regarded as organs of touch; there is hardly any doubt about the fact. Some naturalists make them the seat of the smell; others consider them connected with hearing; and some locate both senses in them. However it may be, they are formed of a series of articulations united to one another, the number and form of which furnish entomologists with good characteristics for classification.

The antennæ are straight or bent. The basilar joint, which is in direct relation with the head, is called the scape; in bent antennæ it is usually very large, and forms an obtuse angle with the next joint. The club, or terminal part of the antenna, is sometimes in the shape of an olive, and is composed of a variable number of joints. The whole number of joints between the scape and the club constitutes the funicle. Characteristic forms of antennæ are represented in Fig. 12.

The thorax comprises three rings more or less closely joined: the prothorax, mesothorax, and metathorax. The prothorax bears the first pair of legs; it is largely developed in the *Coleoptera* and *Hemiptera*, in which it appears as a horny buckler, and is freely articulated with the mesothorax. It is the corselet of the old authors, and is called the *pronotum* by the entomologists of to-day.

The mesothorax bears the second pair of legs and the first pair of wings, which are sometimes horny; we perceive on the upper part of the insect only a small triangular portion of it, which is hardly visible in some species, and is called the *scutellum* or escutcheon. All the rest of the dorsal part is covered by the wings.

The metathorax is closely united to the preceding ring, and frequently also to the first rings of the abdomen. It bears the

second pair of wings, which are always membranous when they are not atrophied, and the third pair of legs. The ventral part of the thorax is called the *sternum*, and the lateral pieces are the *epimĕra*.

The wings, usually four, are sometimes reduced to two, and may even disappear entirely, when the insect is said to be apterous. The two pairs of wings, when they exist, are unlike, as in the *Coleoptera* and bugs, or alike, as in the *Hymenoptera* and *Neuroptera*. When they are unlike, those of the first pair have a horny consistency. They form a protecting case for the wings of the second pair, and are called *elytra;* the wings of the second pair are membranous, and are supported only by a network of nerves, which forms a kind of framework for them. Of this character are the wings of the cockchafer and stag-beetle. In the elytrum we distinguish the base, or part adjacent to the prothorax; the shoulder, or fore-external part; the humeral callosity, a more or less pronounced lump near the shoulder; the suture, an inner part, by which the elytra at rest are in contact; the humeral angle, or external basilar angle (of the side of the shoulder); the scutellary angle, or inner basilar an-

FIG. 12.—ANTENNÆ. 1. Setiform antenna. 2. Setaceous antenna. 3. Filiform. 4. Fusiform. 5. Serrated. 6. Pectinate. 7. Flabellate. 8. Clubbed. 9. Lamellated. 10 and 11. Bent.

gle (of the side of the escutcheon); the summit or extremity of the elytra; and the sutural angle, formed by the line of the suture with the outer edge at the summit of the elytra.

The elytra are not always entirely horny. In the heteropterous *Hemiptera*, the elytra remain membranous for a considerable extent near the summit. When the two pairs of wings are alike, both are membranous, and are constituted on the same plan as the wings of the second pair in *Coleoptera*. Of this character are the wings of the bee, the hornet, dragon-fly, and butterfly. The wings of the last are furthermore covered with brilliantly colored scales. The wings of the *Diptera* (flies, gnats, etc.), with their finely reticulated nervation, present the same membranous appearance; but the second pair are wanting, the only representatives left of them being small appendages known as balancers.

The legs are shaped for leaping (Fig. 13, A), for walking (B), or for swimming (C). Whatever may be their use, the general plan of their structure remains the same, and the modifications bear only upon one or the other of their constituent elements. Thus in the mole-cricket the legs of the first pair are adapted to digging the ground (D); those of the praying mantis (E F) are shaped like pincers; the lower leg, attached to the upper by a very supple joint, bends back upon it, as is shown in F, and forms with it a vise, the interior of which bristles with fine toothings suitable to hold captive any prey that may be taken. What it has been agreed to call the leg of an insect comprehends the coxa (*a*), the trochanter (*b*), the femur (*c*), the lower leg or tibia (*d*), and the tarsus (*e*). The coxa is short, and is articulated into a cavity of the epimerum called the cotyloid cavity. The trochanter, which follows it, assists the movements of the femur joint. The femur is a strong lever which, in the case of insects organized for leaping, is considerably developed in the hinder

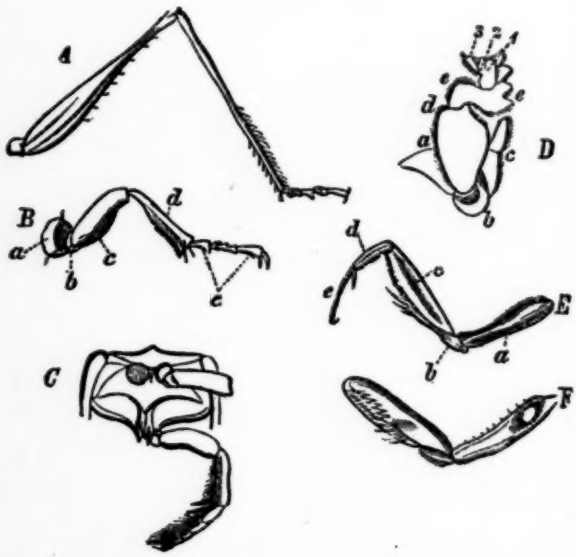


FIG. 13.—DIFFERENT FORMS OF LEGS.

legs (Fig. 13). The leg has the form of an elongated trapeze, the major base of which is often provided with spurs, while the crest is covered with teeth or rigid hairs. The tarsus is composed of joints, not exceeding and not always reaching five in number. These short joints are of different forms. They are sometimes furnished with fine balls of silk, a kind of brushes which aid in standing—or with suckers answering the same purpose. The last joint of the tarsus, called the *onychium*, bears one or two nails. The joints of the tarsi are generally distributed in equal numbers upon all the legs of the insect; but there are sometimes fewer on the middle and after limbs than on the fore limbs.

The arrangements we have pointed out hold with the walking insects; with aquatic insects the rugosities of the joints are smoothed down, the nails are blunted, and the legs are transformed into ciliated paddles that permit the animal to move easily in the water.

FIG. 14.—FOOT OF A FLY. *p*, pelotes; *g*, nails.

The abdomen consists of a series of rings joined to one another by a fine membrane which gives them great mobility. It is by means of this disposition that the abdomens of females when distended with eggs attain such extraordinary proportions. The number of abdominal segments varies from six to nine. The last ones are sometimes transformed into accessories of the genital apparatus. The last horny arch of the abdomen is called the *pygidium*, as in the tail of the cockchafer.

The cutaneous envelope of insects is usually of a dull, ruddy, or pitchy color; sometimes clearer, sometimes of a metallic appearance; but that which constitutes their richest livery is the investment of their external skeleton. This investment is formed of silks, felted hairs, spines, or thin caducous scales, the overlaying of which composes most original designs. A moderate enlargement is sufficient to give some species the appearance of brilliant jewels; seen under the lens, the *Curculio imperialis*, a Brazilian beetle, appears like a real set of emeralds and diamonds. Nothing is more interesting than to observe the fine pubescence of our native weevils and the delicate scales of the coats of some individuals. All these ornaments are, however, so fragile that we only have to graze a butterfly's wing with the finger to scatter

all the chatoyant dust, and to lay bare the transparent membrane which it covered.

Some *Coleoptera*, as the *Larinus* and the *Polydrosus*, become unrecognizable when an awkward hand has stripped them of their magnificent raiment; the emerald robe and the curious designs disappear, to give place to the dark coloring of the teguments.

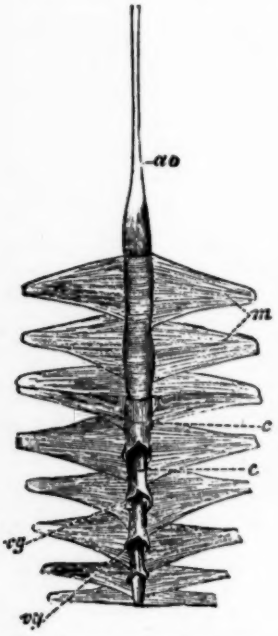


FIG. 15.—CIRCULATORY APPARATUS OF THE COCKCHAFER. *ao*, aorta; *c*, dorsal vessel; *m*, suspensory ligaments of the wings. (Strauss-Durckheim, Anatomie comparée des animaux articulés.]

The circulatory apparatus of insects (Fig. 15) comprises a dorsal vessel (or heart), from which the ramifications start that distribute the life-giving fluid through the organization. The nervous network (Fig. 16) extends over the ventral face of the animal in the shape of two ganglionic cords which come together under the digestive tube to separate again into two branches. The latter embrace the œsophagus like a collar, and meet above it to inclose the cerebral mass.

As we have just seen, the nervous system is specially localized in the ventral region, while the seat of the circulatory apparatus is chiefly in the dorsal region. This is almost the exact contrary of what is remarked in vertebrates.

The digestive apparatus (Fig. 17) is situated between the circulatory and the nervous networks. The respiratory orifices, which give passage to the air, are distributed along the body. They are called *stigmata*. Upon them abut the tracheæ, tubes of an extreme tenuity, the interlacings of which branch out through the tissues.

The whole body of the insect is sensitive to touch, but the perception of sensations takes place chiefly by hairs in direct relation with the nervous system. These hairs are found more or less all over the creature, but particularly upon the antennæ and at the ends of the palpi.

The convenient arrangement of the eyes enables the insect to see all around itself without making any motion. The length of its view has not been precisely determined, but experiments seem to show that it is not great. The part played by the *ocelli* is also not clearly determined. In insects living in dark places, especially in those strangely shaped ones that live in caves, the organ of sight is atrophied, and is represented only by little swellings hav-

ing the nervous filaments spread over their centers. These animals are not entirely insensible to the action of light; for they shrink from it and exhibit signs of being disagreeably affected when they are exposed to it.

The faculty of hearing is greatly developed among insects. The slightest noise disturbs them—yet the position of the organ of hearing has not been well defined. Maurice Girard* assumes that its seat is in the antennæ; and in the absence of a special organ, that it acts like a flexible rod, free at one end, and attached by the other end to an elastic membrane. M. Künckel agrees with Müller and Siebold that the organ of hearing is situated outside of the head.

FIG. 16.—NERVOUS SYSTEM OF THE ADULT BEE. (After E. Blanchard, Metamorphoses.)

The smell and the taste, on the other hand, belong entirely to the cephalic region. The taste is seated near the mouth; the smell is one of the appanages of the antennæ. This has been irrefutably demonstrated by M. Balbiani, who, taking a number of newly hatched male silkworm moths, and isolating them from contact with females, divided them into two lots, which he placed in different boxes. One of the lots was left undisturbed, the other was subjected to experiments. The pectinal antennæ of all the individuals in it were cut off at the roots. On bringing tables on which were females near the boxes containing undisturbed moths, the insects were observed, even at a distance of several yards, to beat their wings and become violently agitated. But when females were brought near the moths that had been deprived of their antennæ, they showed no signs of being affected; their wings remained flat and motionless. The strong exhalations from the females were imperceptible to them; the removal of their antennæ had deprived them of the power of smelling.† Other naturalists, however, give the power of perceiving odors to the stigmata.

Locomotion is performed in insects, as in vertebrates, by means

* Maurice Girard, Traité d'Entomologie, comprising the history of useful species and their productions, and of injurious species and the means of destroying them.

† Brehm, Les Insectes. French edition, by J. Künckel d'Herculais. Paris: J. Baillière et fils.

of levers moved by muscles; but in the vertebrates the lever is within and the motor muscles are without, while in insects the muscles are inside and the lever outside. We have already pointed out the adaptation of the legs to the habits and the abode of the animals. The hairs with which the tarsi are furnished have a part in permitting flies to move on polished objects and to assist the rapid course of hydrometers, or skippers, on the surface of water. The wings sometimes come into play in propulsion on water; they are then furnished with long cilia, forming broad oars. The mechanism of flight has been the object of important studies by Pettigrew and Marey. A wasp, the ends of whose wings have been gilded, presents the appearance as shown in Fig. 19. The dispositions of the elytra of the *Coleoptera* during flight are extremely various. Poujade has given some interesting drawings of them in the annals of the Entomological Society of France. In them the cock-chafer, the *Onthopagus*, is shown simply raising its elytra, the *Necrophorus* lifting them in a plane perpendicular to that of the body, and another genus holding them closed as in a position of rest. Sometimes, also, in moving through the air, the middle legs are raised above the body.

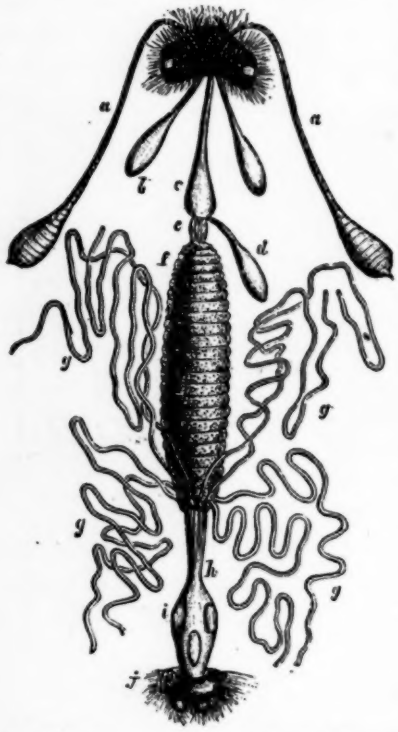


FIG. 17.—DIGESTIVE APPARATUS OF A SUCKING INSECT (*Ascalaphus meridionalis*). *a a*, antennæ; *b*, salivary glands; *c*, œsophagus; *d*, stomach; *e*, gizzard; *f*, chylific ventricle; *g g*, tubes of Malpighi; *h*, intestine; *i*, rectum; *j*, last segment of the abdomen. (After Léon Dufour.)

FIG. 18.—DISPOSITION OF THE STIGMATA OF A SILK-WORM. *S*, stigmata of the first ring; *S'*, stigmata of the fourth ring; *S''* to *SVIII*, stigmata situated on the fifth, sixth, and eleventh rings.

A considerable number of insects secrete products, some of which are useful, while others are injurious. First in order

among useful secretions are silk and wax. Silk is furnished more or less abundantly by all the caterpillars and many other larvæ. The silkworms produce it in large quantities.* Wax is produced by a number of *Hymenoptera*, which construct cells of it to hold honey. Aphides and cochineals secrete fatty matters, the white tufts of which form a kind of down on their bodies and on the plants they frequent. In other insects the secretions become a defensive armor. Thus the *Hymenoptera* drop poison in the wound made in animal tissues by their sting, which it causes to swell. An analogous stinging gives rise to the excrescences called galls, with which the leaves of trees are

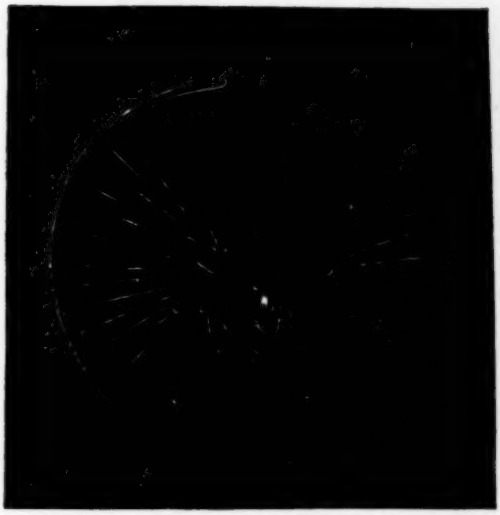


FIG. 19.—APPEARANCE OF A WASP IN FLIGHT.

FIG. 20.—SCAPHINUS REPELLING THE ATTACK OF A CARABUS.

often covered. Many of the *Coleoptera* emit penetrating odors. The *Cicindela* smells of the rose, the *Aromia moschata* of musk; the anal glands of the carabicus produce butyric acid; while

* See Leo Vignon, La Soie au point de vue scientifique et industriel. Paris, 1890 (Bibliothèque des Connaissances utiles).

some of these *Coleoptera* eject by the anus a caustic liquid which, vaporizing suddenly, detonates with intensity, like an explosive; whence the *Brachini* have been called bombarders.

THE PEARL OF PRACTICE.

By ELIZABETH ROBINSON.

THE Wakefield family have always been very proud of tracing their descent from an old English doctor who came to this country in the latter part of the seventeenth century. Proudly they show the various relics of this highly respected ancestor—his old battered silver snuff-box, with dim, worn inscription, telling that it was a gift from a scion of nobility, who thus rewarded his medical man for service done in his cause; the comical night-cap which once covered the dear doctor's revered head, a pair of shoe-buckles, a few buttons from his small-clothes, and last, but not least, an old account-book and book of prescriptions. The account-book opens of itself at the pages where noble names are most often inscribed: "A purge for Lady Mary Brown"; an emetic (the good doctor uses a more Shakespearean word) for Lady Betty Smith, a draught for this lord, a blister for that, etc.

We turn with due consideration the thin, yellow pages, covered with fine, faded writing, still perfectly legible, queerly spelled. The book of prescriptions, The Pearl of Practice, is so old, so near dropping in pieces, that it surely has to be taken up tenderly, handled with care. It has every appearance of great age, and we are not surprised to learn that it was printed in London two hundred and seven years ago. The ancient volume shows evidence of much consultation. We open it with respect, which quickly turns to righteous horror and indignation as we peruse the crumbling pages. We can only hope that this venerated disciple of Æsculapius practiced mostly in his own country, and did not work fell disaster in the struggling colonies of America. Truly British brawn and the accessory of England's climate were needed even for the "survival of the fittest" if many of these strange and wonderful prescriptions were followed. Even so early in our history the Americans were far too "nervous" to bear many such heroic doses, even if the true nature of the ingredients could have been concealed. Perhaps we have always had a leaning toward the "new school" of medicine; a little study of these old pages quite convinced us of it. But we fancy the most conservative physician of the "old school" to-day would not go very far by this queer little book.

In the first place, one would have to be the happy possessor of

an independent fortune to be able to compound many of the remedies; no drug-store would carry such expensive materials. "Amber-greece," pearls, coral, and gold were in as common use then as quinine has been during the recent reign of *la grippe*.

The following powder comes in the list of "Choice Physical and Chirurgical Receipts." We are not told in what disease or diseases it is warranted to kill or cure. A "universal remedy," mayhap; should judge it to be powerful:

"*The Bishop of Worcester's admirably curing Powder.*—Take black tips of Crabs' claws when the Sun enters into *Cancer*, which is every year on the eleventh day of *June*; pick and wash them clean, and beat them into fine powder, which finely searce; then take Musk and Civet, of each three grains, Amber-greece twelve grains, rub them in the bottom of the Mortar, and then beat them and the powder of the Claws together; then with a pound of this powder mix one ounce of the magistery of Pearl.* Then take ten skins of Adders, or Snakes, or Slow-worms, cut them in pieces and put them into a pipkin to a pint and a half of Spring-water; cover it close, and set it on a gentle fire to simmer only, not to boyl, for ten or twelve hours, in which time it will be turned into Jelly, and therewith make the said powder into balls.

"If such skins are not to be gotten, then take six ounces of shaved Harts-horn, and boyl it to a jelly, and therewith make the said powder into balls; the horn must be of a red Deer killed in *August*, when the Moon is in *Leo*, for that is best.

"The Dose is seven or eight grains in beer or wine."

There are many references to "the Plague," from "an excellent perfume against the Plague," to strange drinks and medicines to be used both before and after "infection." We will give the oldest receipt first:

"*A Drink for the Plague or Pestilent Fever, proved by the Countess of Arundel, in the Year 1603.*—Take a pint of Malmsey, and burn it, and put thereto a spoonful of grains, being bruised, and take four spoonfuls of the same in a Porringer, and put therein a spoonful of Jean Treacle, and give the Patient to drink as hot as he can suffer it, and let him drink a draught of the Malmsey after it, and so sweat: if he be vehemently infected he will bring the Medicine up again; but you must apply the same very often day and night till he brook it, for so long as he doth

* "*To make true Magistery of Pearl.*—Dissolve two or three ounces of fine seed Pearl in distilled Vinegar, and when it is perfectly dissolved, and all taken up, pour the Vinegar into a clean glass bason; then drop some few drops of Oyl of Tartar upon it, and it will cast down the Pearl into fine powder, then pour the Vinegar clean off softly, then put to the Pearl clear Conduit or Spring water; pour that off and do so often until the taste of the Vinegar and Tartar be clean gone, then dry the powder of Pearl upon warm embers and keep it for your use."

bring it up again there is danger of him; but, if he once brook it, there is no doubt of his recovery by the Grace of God; provided then when the party infected hath taken the aforesaid Medicine and sweateth, if he bring it up again then you must give him the aforesaid quantity of Malmsey and grains, but no Treacle, for it will be too hot for him, being in a sweat. This Medicine is proved, and the party hath recovered, and the sheets have been found full of blew marks, and no sore hath come forth; this being taken in the beginning of the sickness. Also this medicine saved thirty-eight Commons of Windsor the last great Plague 1593, was proved on many poor people, and they recovered."

In "The King's Medicine for the Plague," a very simple herb drink, one is assured that after taking it the first day "you shall be safe four-and-twenty days, after the ninth day a whole year by the grace of God." This next remedy for the plague would hardly be found available in a great city; the poor people of plague-stricken London were, one fears, never able to profit by it, as it calls for wholesale slaughter, not of the innocents, but of as harmless feathered bipeds. "Mr. Winlour," whoever he may be, who found this prescription so effectual, was no doubt a suburban gentleman with cock-chicks galore at his command:

"*A Medicine for the Plague which the Lord Mayor had from the Queen.*—Take of Sage, Elder, and red Bramble leaves, of each one little handful; stamp and strain them together through a cloath with a quart of White-wine; then take a quantity of White-wine-Vinegar, and mingle them together; and drink thereof morning and night a spoonful at a time nine days together, and you shall be whole. There is no medicine more excellent than this, when the sore doth appeare, than to take a Cock-chick and pull it, and let the Rump be bare, and hold the Rump of the said Chick to the sore, and it will gape and labour for life and in the end die; then take another, and the third, and so long as any one do dye; for when the poyson is quite drawn out the Chick will live, the sore presently will assuage, and the party recover. *Mr. Winlour* proved this upon one of his own Children, the thirteenth Chick dyed, the fourteenth lived, and the party cured."

Cock-chicks, especially "running" ones, were in great demand in those bygone days; they enter into the composition of many of these "excellent receipts" either in an active or passive state.

"*Cock-water for a Consumption.*—Take a running Cock-chick, pull him alive, then kill him, cut him abroad by the back, take out the entrails and wipe him clean, then quarter him and break his bones, then put him into a Rose-Water Still with a pottle of Sack, Currans, and raisins of the Sun stoned, and figs sliced, of each one pound, Dates stoned and cut small half a pound, Rosemary

Flowers, Wild Time, Spearmint, of each one handful, Organs or wild Marjoram, Bugeloss, Pimpinel, of each two handfuls, and a pottle of new milk from a red Cow. Distill these with a soft fire, put in the Receiver a quarter of a pound of brown Sugar candy beaten small, four grains of Amber-greece, forty grains of prepared Pearl, and half a book of leaf gold cut very small; you must mingle the strong water with the small, and let the Patient take two spoonfuls of it in the morning and as much at going to bed."

Although this precious Pearl of Practice was published more than fifty years before Mark Twain's Majestic Literary Fossil, the virtues of "*Aqua Limacum*" (in this treasure called "A Special Water for a Consumption") were well known even at that early age. Delicious compound! most truly strengthening and reviving, with its "peck of garden shell snails" bruised in a mortar, shells and all, quart of earth-worms "ripped up" and "scoured with salt," combined and distilled with herbs too numerous to give here. Horrors!

One would surely prefer some of the greatly advertised "emulsions" of the present century. We can not believe that such slow creatures as snails were ever very common in the "rapid" life of America. So we trust that our beloved forebears were not dosed with many snail elixirs. One might consent to their use in "anointing," but draw the line at drinking their juices.

"*To Anoint the Ricketed Child's Limbs, and to recover it in a short time, though the Child be so lame as to go upon Crutches.*—Take a peck of Garden Snails and bruise them, put them in a coarse Canvas Bag, and hang it up, and set a dish under it to receive the liquor that droppeth from them, therewith anoint the Child in every joynt which you perceive to be weak, before the fire every morning and evening. This I have known make a Child that was extream weak to go alone, using it only a weeks time."

By the many receipts given for curious oyls, plaisters, oyntments, and salves, one judges that the efficacy of "outward applications" was seldom called in question.

"Oyl of Swallows" attracts one's attention; it would be very hard to "make." What kind of swallows? where could one find them, and how catch them? "Take Swallows as many as you can get, ten or twelve at least, and put them quick into a Mortar." Alive or dead? feathers and all? we query. Unto these "pounded" swallows are added many herbs and spices. "Neat's-foot Oyl or May butter," much "wax and a pint of Sellet-Oyl," the whole mess strained through a canvas cloth. Truly a fine oil for divers complaints. From the salves we of course choose the "chief," and one we must believe used by nobility if not royalty:

"*Sir Edward Tertil's Salve called the chief of all salves.*—Take Rosin eight ounces, Virgins wax and Frankincense, of each four ounces, Mastick one ounce, Harts suet four ounces, Camphire two Drams, beat the Rosin, Mastick and Frankincense in a Mortar together to fine powder; then melt the Rosin and Wax together, then put in the powders; and when they are well melted strain it through a cloath into a pottle of white Wine, and boyl it together till it be somewhat thick; then let it cool, and put in the Camphire and four ounces of Venice Turpentine drop by drop, lest it clumper, stirring it continually, then make it up into Rolls, and do with it to the pleasure of God, and health of man.

"*The Vertues and use of it:* 1. It is good for all wounds and sores old or new, in any place. 2. It cleanseth all Festers in the flesh, and heals more in nine days than other salves cure in a month. 3. It suffers no dead flesh to engender or abide where it comes. 4. It cureth the Head-ach, rubbing the Temples therewith. 5. It cures a salt fleam Face. 6. It helpeth Sinews that grow stiff, or spring with labour, or wax dry for want of blood. 7. It draweth out rusty Iron, Arrow heads, Stubs, Splints, Thorns, or whatever is fixed in the flesh or wound. 8. It cureth the biting of a mad Dog, or pricking of any venomous creatures. 9. It cureth all Felons or white-flaws. 10. It is good for all festering Cankers. 11. It helpeth all Aches of the Liver, Spleen, Kidneys, Back, Sides, Arms or Legs. 12. It cureth Biles, Blanes, Botches, Imposthumes, Swellings, and Tumors in any part of the body. 13. It cureth Scab, Itch, Wrenches, Sprains, Strains, Gouts, Paulsies, Dropsies, and waters between the flesh and skin. 14. It healeth the Hemorrhoids or Piles in Man or Woman. 15. Make a search-cloth thereof to heal all the above-said Maladies, with very many others which for brevity sake are omitted."

A "Balsam" of use for infected brains may appeal to the overtaxed student:

"*To cure Diseases without taking anything at the mouth.*—Take one pound of Aloes Hepatica, Myrrhe four ounces, both beaten very fine, *Aquavitæ* and Rose-water, of each one pint; after one nights infusion distill them in Sand twenty four hours very softly, and in the end make a great fire, and there will come a Balsam wherewith if you rub the Stomach with a warm cloath dipped therein, it will Purge Phlegm and Choler, and all worms which infect the brain, and breed the Falling-sickness, it expelleth corruption of the Stomach, it helps digestion and appetite, it expurgeth all dross in the bottom of the Stomach, it cureth the Gout being mixed and well beaten with *Aquavitæ*, and applyed warm to the Gouty place and left long on it."

Here is a genuine faith-cure of "y^e olden time," though for that matter most of these ancient prescriptions require faith as

well as courage in the patients partaking of the strange admixtures:

"*To cure a Wound, though the Patient be ever so far off.*—Take a quart of pure Spring water, and put into it some Roman Vitrol and let it dissolve, then if you have any blood of the wound either in linnen or wollen or silk, put the cloth so blooded into the water, and rub the cloth once a day, and if the wound be not mortal, the blood will out, if it be, it will not. Let the Patient keep his wound clean, washing it with white wine; when ever you wash the cloth, the Party wounded shall sensibly find ease; let the cloth be constantly in the water."

One is hardly surprised to find, among the other horrors in these medicinal compounds, that "dung" of various and sundry kinds plays an important part. Read this rare combination of game and fertilizing materials, in juxtaposition with the household "staff of life":

"*Dr. Baffa, an Italian. An approved Receipt to break the Stone in the Kidneys.*—In the Month of May distill Cowdung, then take two live Hares, and strangle them in their blood; then take one of them, and put it into an earthen vessel or pot, and cover it well with a mortar made of Horsedung and Hay, and bake it in an Oven with household bread, and set it still in the Oven for two or three days, baking it anew with anything, until the Hare be baked or dryed to powder; then beat it well, and keep it for your use. The other Hare you must flea, and take out the guts only; then distill all the rest, and keep this water; then take at the new and full of the Moon, or any other time, three mornings together as much of this powder as will lie on a sixpence, with two spoonfuls of each water, and it will break any stone in the Kidneys."

Then this "pretty" drink:

"*The Lady Gorings Water for an Ague, sickness or foulness in the Stomach, and to purge the blood.*—Take dung of a stone-horse that is kept in the stable, when it is new made, mingle it well with Beer and a little Ginger, and a good quantity of Treacle, and distill in an ordinary still; give of this a pretty draught to drink."

Truly loathsome, perfectly disgusting, we say; "reely nasty," "beastly," perhaps our English cousins said.

We often hear people complain of the elongation of the palate (uvula), and they have recourse to many remedies, surgical and otherwise; even if one could believe that the uvula could be affected from the top of the head, through skull, brains, and all, would the "cure" here given work on a thick head of hair, or is it only applicable to the bald-headed?

"*To draw up the Uvula.*—Take a new-laid Egg, and roast it till it be blue, and then crush it between a cloath, and lay it to the

Crown of the Head, and once in twelve hours lay new till it be drawn up."

"*Dr. Adrian Gilbert's most Soveraign Cordial Water*" contains, among other things too numerous to mention, from one to two pounds each of thirty-nine different plants, "two pounds of shaved Hartshorn, twelve ounces of Ivory, a goodly quantity of Clarret wine and best Malaga Sack," all distilled.

When small-pox, plague, spotted fevers, and ordinary fevers are abroad in the land, "if one take, in time of infection, two spoonfuls of this Cordial water in good Beer or white Wine he may safely walk from danger by the leave of God."

Another "*Soveraign Water*" of Dr. Stephens's, "which he a long time used, wherewith he did many cures; he kept it secretly till a little before his death, and then he gave it to the Lord Arch-Bishop of Canterbury, in writing." It does not differ greatly from the preceding, but oh the virtues of it!

"*The Virtues of this Water.*—It comforts the Vital Spirits, and helps all inward Diseases that come of cold; it is good against the shaking of the Palsie; it cures the contraction of the Sinews; it kills the Worms in the Belly and Stomach; it cures the cold Dropsie, and helps the Stone in the Bladder, and in Reins of the Back; it helps shortly the stinking breath, and whosoever useth this Water morning and evening (and not too often) it preserveth him in good liking and will make him seem young very long, and comforteth Nature marvelously; with this water did Mr. Stephens preserve his life till extreme age would not let him *go or stand;* and he continued five years when all the Physicians judged he would not live a year longer, nor did he use any other Medicine but this."

Another "*Aqua Mirabilis, Sir Kenelm Digby's way,*" is more simple in build but as wonderful in effect.—"This water preserveth the Lungs without grievances, and helpeth them; being wounded, it suffereth not the blood to putrifie, but multiplyeth the same; this water suffereth not the heart to burn, nor Melancholy, nor the Spleen to be lifted up above nature; it expelleth the Rhume, preserveth the Stomach, Conserveth youth, and procureth a good colour; it preserveth memory; it destroyeth the palsie; if this be given to one a dying, a spoonful of it reviveth him; in the Summer use one spoonful a week fasting, in the Winter two spoonfuls."

If one can judge by the number of prescriptions given, small-pox was more common two hundred years ago than measles now. "Megrims," "melancholy fumes," "fainting of the heart," "passion" of the same, were as well known as the "nervous prostration" of these later days.

We fail to see the true meaning in the title of the receipt next

in order. Does the patient (poor victim!) or the mixture of long-named ingredients "hum"? And why "damnable"?

"*A Receipt to make Damnable Hum.*—Take spices de Gemmis Aromaticum Rofatum, Diarrhodon Abbatis, Letificans Galeni, of each four drams, Loaf-sugar beaten to a powder half a pound, small Aqua Vitæ three pints, strong Angelica water one pint; mix all these together, and when you have drunk it to the Dregs, you may fill it up again with the same quantity of water. The same powders will serve twice, and after using it it must be made new again."

Some of the receipts have been "proved"; for instance:

"*The Lady Drury's Medicine for the Colick, Proved.*—Take a turf of green grass, and lay it to the Navil, and let it lye till you find ease, the green side must be laid next to the belly."

Another was "Proved by Mrs. Joyce, Widow."

We must finish our study of this most fascinating, quaint little leather-bound volume; but a strange title attracts us here, a stranger ingredient there, and it is hard to stop—for example: "A very good glyster for the Wind." "Syrup of Turnips." "A purging Juleb." "A Vomit for an Ague." "A Cordial Electuary for Stuffing of the Stomach." "For a Noli me tangere." "For pin and web in the eye."

Scraped amber taken in hot broth is a truly "precious" draught for fainting.

For stomach-ache one is told to cut "scarlet" into the shape of a heart, wet it in strongest cinnamon or wormwood water, heat it, and lay very hot to the stomach.

"The Claws of a Goat burned to Powder"; "Unicorns-horn"; "Blue Lilly roots"; "Woodlice, dried, and made into fine powder"—all to be taken internally! Split salt herrings applied to the feet in fever.

Let us be thankful that we live in this nineteenth century, albeit one of multitudinous patent medicines, hypnotism, Christian science, and magnetic and electric remedies. We humbly trust that what little medicine we are forced to take will better bear analyzing than the strange pharmaceutical compositions of animal, vegetable, and mineral matters gleaned from the Wakefield heirloom. We return this treasure with many thanks. It is eagerly seized and quickly locked up in the grandfather's desk almost as ancient as itself. We are assured that it is regarded as a priceless "Pearl," and worth more to its owners (from its antiquity and associations rather than its intrinsic value, we suppose) than its weight many times over in purest gold.

THE FUTURE OF THE DRY LAND.*

By M. A. de L'APPARENT.

I PURPOSE to inquire briefly into the probable future of the dry land, to ask if it is not destined to disappear, and to estimate the time that may be required to execute a sentence of extinction against it. It would have been hazardous to touch upon this question a few years ago. Precise data were wanting as to both the value of the relief of the land and the intensity of the actions which are called into play to change it. But the progress of geographical study has now put us in possession of more exact information, enough to permit us to seek a solution of the problem, not in the expectation of getting exact figures, but of calculating approximately the magnitude of the effects which we have to contemplate.

The labors of geographers in later years have given us a much more complete knowledge than we had before of the land relief. Ten years ago we still accepted Humboldt's estimate that, if all the asperities of the land were leveled over its entire surface, the resultant plateau would stand 305 metres above the surface of the sea. This figure began to grow perceptibly about 1880. A German student, Herr Krümmel, raised it to 444 metres. A few years ago, I thought it best, in preparing the chapter in my Traité de Géologie bearing upon this subject, to go into new calculations on the basis of existing hypsometric maps, and I came to the conclusion that the mean altitude of the dry land would be more than 500 metres, and would probably approach 600 metres. I declared this result with some reserve, on account of its novelty. But I had the satisfaction of seeing it immediately accepted by foreign geographers, and my estimates have since been exceeded; for Messrs. John Murray, Penck, Supan, and De Tillo, having been able, by the aid of the cartographic documents accessible to them, to make still more precise calculations, have found that the land relief may be represented by a uniform plateau rising to 700 metres above the level of the sea.

This plateau of 700 metres is the object of incessant attacks by the ocean on one side and atmospheric agents on the other. The rivers never cease carrying to the sea the fine fragments of the rocks which the rain washes into them, after they have been disintegrated by the alternate actions of moisture and drought, cold and heat, freezing and thawing. By observation of what takes place at the mouths of rivers, we may succeed in reaching a clear idea of the measure in which the silent action of atmospheric agents

* Address before the Geographical Society of Paris.

pares away the continental masses. Mr. J. Murray, of Scotland, from the study of all that has been published on this subject, of which he has himself furnished a considerable proportion, has found that the outflow of the nineteen principal rivers of the earth is 3,610 cubic kilometres a year. These 3,610 cubic kilometres bring to the sea a mass of solid matter in suspension equivalent to one cubic kilometre and $\frac{338}{1000}$, making a proportion in value of 38 parts per 100,000. On the other hand, meteorological observations have become precise enough to enable us to estimate approximately the annual outflow of all the rivers of the earth. Mr. Murray puts it at 23,000 cubic kilometres. Applying to this figure the same proportion of 38 per 100,000, we get, for the amount of solid matter annually carried mechanically to the sea by rivers, 1,043 cubic kilometres. That is the effect of the mechanical action of the continental waters.

What part do the waves of the ocean take in this action? When we hear the noise of the waves breaking against the bluffs and throwing their grape-shot of pebbles against them, and when we witness the enormous land-slides of which the sea-shores are often the theatre, we are sometimes led to think that the action of the sea is a preponderant factor in the destruction of continents. But the reverse is the case.

England may be regarded as one of the countries in which attacks by the sea upon the coast are most intense; for the waves of the Atlantic are thrown very violently against the shore by the southwest winds. English geologists appear to be agreed in thinking that the waste of the coasts of Britain under the action of the sea is certainly not more than three metres a century. It is true that at certain points of the French littoral, as at Havre, the banks are estimated to lose a quarter of a metre a year. M. Bouquet de la Grye raises the loss to a little more than a metre a year on the limestone coasts of the southwest; but, in compensation, there are seas where the work of the waves may be neglected as null, as well as flat coasts, where the sea, building up littoral bars, adds instead of taking away. I believe, then, till the contrary is proved, that if we allow for the whole earth a waste of three metres in a hundred years, we are above rather than below the truth.

If we suppose that the shore-banks average fifty metres in height, it follows that an annual waste of three centimetres will remove a cubic metre and a half per running metre, or 1,500 cubic metres per kilometre. The extent of the sea-coasts of the earth can be easily calculated with the aid of the figures given in Elisée Reclus's Continents, showing the proportion, in each continental unit, of dry-land surface and extent of coast-line. Applying these figures to those which represent the surface, now well

known, of the different countries, we get 200,000 kilometres as the total length of the coast-lines. Hence, the supposed loss of 1,500 cubic metres per kilometre per year would give 300,000,000 cubic metres, or three tenths of a cubic kilometre. Thus, while the running waters take away ten and a half kilometres, the sea does not remove one twentieth of that quantity. Even supposing I have underestimated the height of the coast-banks, and have not given enough importance to the annual waste, let the figures I have used as the base of my calculations be tripled, we still find the effect of sea action a mere fraction, hardly significant, of that which is produced by the silent wash of the rivers. We can say here, as in many other cases, that what does the most work is not that which makes the most noise.

We have, in addition to this, to consider the solvent action of continental waters. They partially dissolve all the rocks, aided, as they are in the action, by carbonic acid; and they come to the sea charged with a considerably larger proportion of matter in solution than one would at first be liable to suppose. According to the labors of the English, American, and International commissions, which have especially studied the composition of the waters of rivers, particularly of the Mississippi, Danube, and Thames, the quantity of solid matters brought down in solution from the continents is not less than five cubic kilometres a year. This, added to the matter carried down mechanically, gives about 15½ cubic kilometres, or, including the results of marine action, 16 cubic kilometres. This, then, is about what the continental masses lose each year.

Let us consider this supposed uniform plateau standing up 700 metres above the level of the sea. By the operation of the circumstances of which I have spoken, 16 cubic kilometres are taken from this mass every year. The continental surfaces covering 146,000,000 square kilometres, we calculate that a waste of 16 cubic kilometres will remove, each year, a layer $\frac{11}{100}$ of a millimetre thick. The *débris* from this layer will settle on the bottom of the sea and assume the form of sedimentary deposits; they will take the place, then, of a corresponding quantity of water, in consequence of which the sea will rise to a certain extent. The ratio of the continental surface being to that of the seas about as 100 to 252, the total result will be a lowering of the height of the plateau of about $\frac{155}{1000}$ of a millimetre every year.

As many times as this $\frac{155}{1000}$ of a millimetre is contained in 700 metres, or 700,000 millimetres, so many years will be required to bring about the disappearance of the dry land. Make the calculation, supposing the present intensity in the phenomena of destruction to continue, and you will find that it will take 4,500,000 years to wear the surface of the earth entirely away. This may be

a reassuring figure to us. But the geologist, who looks at the past as well as at the future, far beyond existing generations, can draw more than one lesson from it. First, the whole history of the globe not being included in a space of time relatively so short, the result teaches us that its equilibrium has more than once been troubled by great phenomena of dislocation, too rare, however, for it to be possible for man to have been a witness of them, which, building up new reliefs as barriers to destruction, have given new impulses to the action of natural forces.

On the other hand, geological observations furnish a tolerably approximate measure of the maximum thickness of the deposits that are made in the bottom of the sea. The total thickness amounts, according to Dana, to 45,000 metres. To learn how long a time may have been occupied with the formation of such deposits, let us seek to represent to ourselves what now becomes of the products of the destruction of the continents.

These deposits, it is now known, do not extend, by a great deal, over the whole surface of the sea bottom; but they form a zone of strata which the deep-sea sounding expeditions have enabled us to define fairly well. According to Mr. John Murray's estimate, the sediments formed by the destruction of the continents spread themselves over about a fifth of the oceanic surface. Thus, although the oceanic area is superior to the surface of the land, the mass of the deposits distributing themselves over only a fraction of the extent, there may result, at the end of 5,000,000 years, an accumulation of sediments capable of forming a body 750 metres thick. But this thickness would certainly be very unevenly distributed; almost null at the finishing point of the deposits in breadth, its thickness would be much greater near the coasts, and it would not be hazardous to suppose that it might rise there to 2,000 or 3,000 metres. To realize the total thickness of 45,000 metres—that is, to explain geological history—it would be sufficient to suppose that the life of the globe has included some fifteen or twenty periods of 4,500,000 years, or from 67,000,000 to 90,000,000 years, a number a little less than the 100,000,000 years which Sir William Thomson has calculated upon estimates of the loss of internal heat.

The objection may be brought up that I have neglected in this calculation the contributions of volcanic action to the land relief, which it is thought should be counted in attenuation of the destructive effect of running waters. We owe to Cordier a calculation that the lavas which have been thrown up during the historical period represent at most 500 cubic kilometres, or, counting that period at 3,000 years, a sixth of a cubic kilometre per year. This is a very little affair compared with the amount of the waste which I have pointed out. We should likewise recollect that

besides eruptions there are also volcanic explosions like those which our generation has witnessed at Krakatoa in 1883, Bangtaisom in 1887, and which our fathers observed at Temboro in 1832. If we reflect that the explosion of Krakatoa threw 16 cubic kilometres of matter into the air, and that of Temboro was still more considerable, we may be permitted to say that volcanic action, instead of diminishing, adds to the constant degradation of the continental relief.

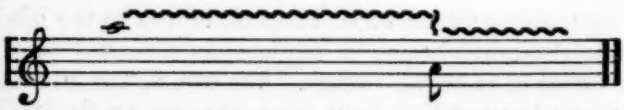
I have not assumed to give precise figures on this subject. My object is less to exhibit numerical results than to present a view of the relative magnitude of the effects under analysis. It is evident that these effects can not be neglected, and that they permit us to assign to the geological history of our globe a duration less than the somewhat fantastic figures to which we have been occasionally asked to give credit.

It is nevertheless true that the disappearance of the continental relief, while it may receive the attention of the geologist and thinker, is not one of those events concerning which present generations need trouble themselves. Neither our children nor our great-grandchildren will have a visible prospect of it presented to them as an actual danger.—*Translated for the Popular Science Monthly from Ciel et Terre.*

THE MUSIC OF THE BIRDS.

By SIMEON PEASE CHENEY.

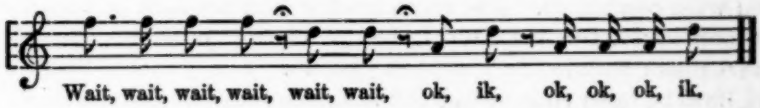
HEN MUSIC.—Late, one night, as I chanced near the hennery with a light, I was rewarded by an exquisite exhibition of the communicative ability of our domestic fowls. The hens moved on their perches; when the rooster spoke, rousing them still more. Stepping back, I soon heard a little sound, high and "exceeding fine," with a deceiving, ventriloquous quality. Long spun, and then bent down in a graceful descent of the interval of a sixth, it terminated in a more decided tone, a peculiar tremor something less than a trill, and died away in a beautiful diminish:

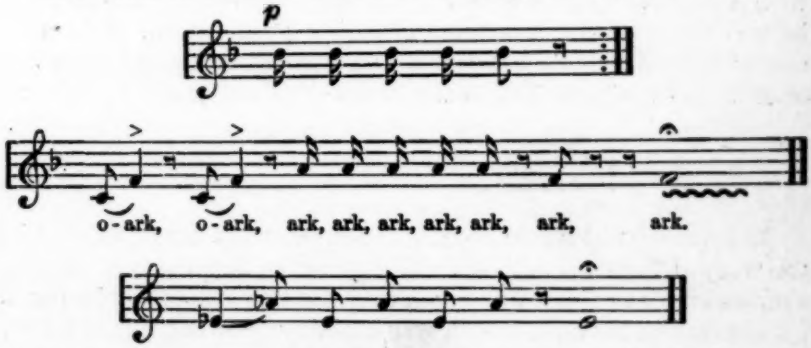


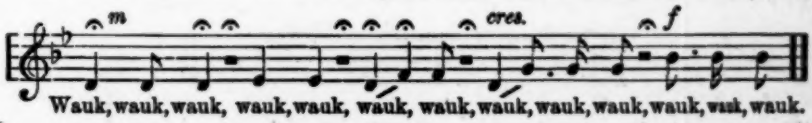
This model example in *pianissimo* practice, and in the art of holding the breath, proved to come from one of the hens; and, though the exact tones are here represented, no idea can be conveyed of the unique, perfect performance. The quieting effect on

the family was instantaneous; not another move or peep. The descent noted is similar to that made by the screech-owl. The intervals are identical; but the hen slides down with an oily smoothness, while the owl, as elsewhere shown, comes trembling, shivering down.

Being an hour late with their breakfast one morning, I was received by the feathered supplicants with unusual demonstrations. They crowded about me so closely I could hardly step without treading on their toes. With heads lifted much higher than one would think they could be, and eyes shining, their tones and inflections were exceedingly human. Like all birds, wild or tame, hens employ, ascending and descending, the intervals of our scale, except in cases as above described; they use the half-step and whole step, the major and minor thirds, the fourth, fifth, and sixth, with a good sprinkling of chromatics. In this instance, every degree of the staff was brought into requisition, the slide of a fourth upward occurring oftenest.



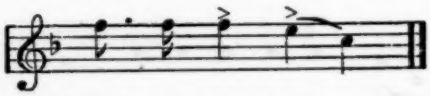
The notes of one hen were all the same, and *piano:*

But the rooster's petition "led all the rest." Striding about in the rear, an occasional brief command attesting his title of "captain," at length he burst out into this sonorous strain:

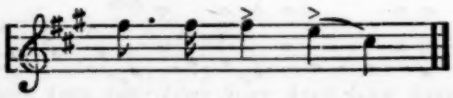


The captain's voice was round and powerful, and his intonation perfect. The slides of the third and fourth were carried up with a noble *crescendo;* and, when he rose to the tonic at the close, the effect was thrilling as that of a clarion blast. What

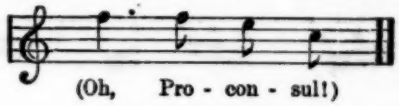
with his sturdy song and dignified, soldierly bearing, the captain's effort was full of hints, in manner and motive, for the composer, the singer, and the orator. When, a few mornings after his notable improvisation, I found the captain's lifeless body, I was not surprised at the gentle demeanor of his many widows; they felt, perhaps more keenly than I, that one of the mighty had fallen.

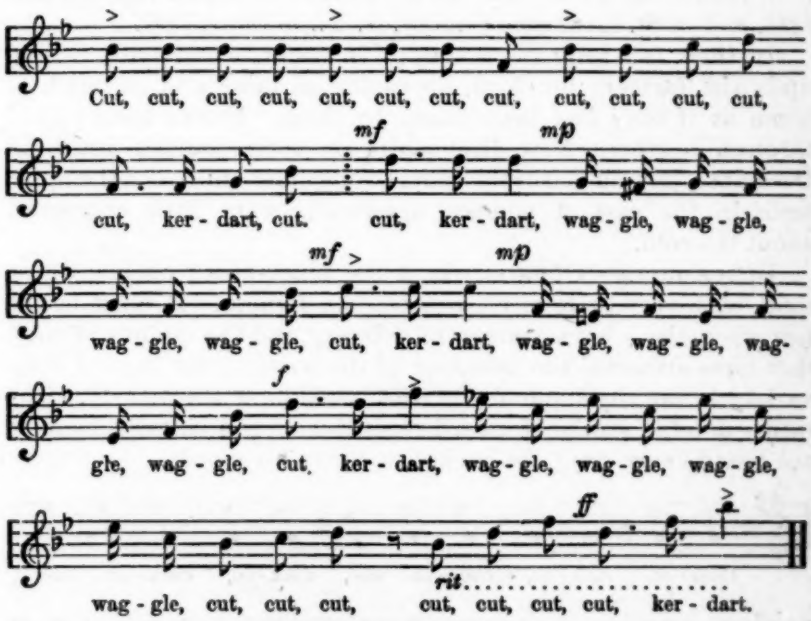
It was several weeks before I found a substitute for the captain; at length a boy brought him, and I saw at a glance that he was the "general." With a word or two by way of greeting, he paused and stood erect before the bereft hens. Soon a pullet, the only shy member of the company, ran to him and put her head close to his. If the general moved, Ruth-like, she moved. A mourner of wider experience was no less interesting in behavior. For some moments she stood aloof in disgust; then, with more ruffle at her neck than was becoming, flew at the general with all fury. The astonished soldier returned several blows, then, checking himself, held his head to the ground, covered with confusion. The fair insulter had no idea of quitting; she continued the onslaught, finally ending it with a series of smart picks square on the lordly comb. The general "grinned and bore it," and thus ended the ludicrous mistake; for a mistake it was, the general fancying for an instant that he was dealing with a foeman worthy of his spur. On discovering his blunder, he was glad to suffer the most crushing humiliation. The newcomer proved a lusty crower; and, after taking his morning call several times, and finding it without variation, I recorded him:



But one day, at a late hour, when he was at large, I heard him use very different intervals. Listening to the strange version over and over again, I was much surprised and perplexed; for, if I had erred in his case, which was a plain one, what might be my errors in intricate cases! I immediately changed the record to the new form, and wrote in the margin, "Every man is a genius in going wrong." But the next morning my ear caught the first form again. The second was this:

The same to the eye, but very unlike to the ear. Had the second form been given in the key of the first, thus:

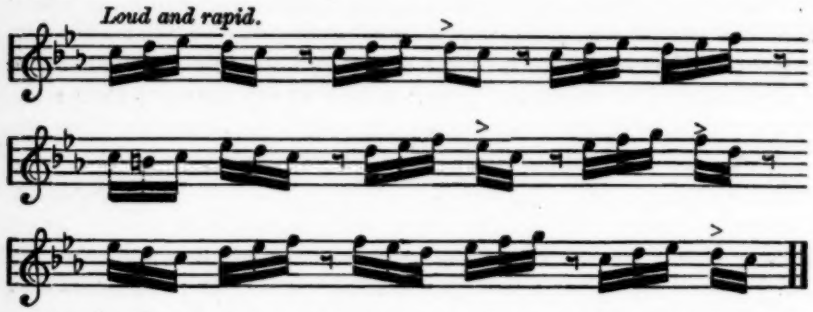
it would have seemed more natural; but, as I was correct in both instances, I reasoned that the rooster might be. I finally settled it that the general's first form was his morning indoor salute, and that the second was his out-of-doors "every-day" song; and, furthermore, that he or some of his ancestry had stolen his text from a strain in "The Seven Sleepers," which in my memory runs:



However, a waggish composer offset this theft when he caught the jubilant cackle of a hen as she broke from her nest, heart and throat full of joyous melody—snatched it bodily, I say, clapped it to paper, and made "Old Dan Tucker":

Cut, cut, cut, cut, cut, cut, cut, cut, cut, cut, cut, cut,
mf
mp
cut, ker - dart, cut. cut, ker - dart, wag - gle, wag - gle,
mf
mp
wag - gle, wag - gle, cut, ker - dart, wag - gle, wag - gle, wag-
f
gle, wag - gle, cut, ker - dart, wag - gle, wag - gle, wag - gle,
ff
rit.
wag - gle, cut, cut, cut, cut, cut, cut, cut, ker - dart.

ROSE-BREASTED GROSSBEAK.—I have had several interviews with this bird in different States, but never when prepared to take more than his key-note; so I give his song mostly from memory, feeling confident, however, of the accuracy of the main features and the spirit of it.

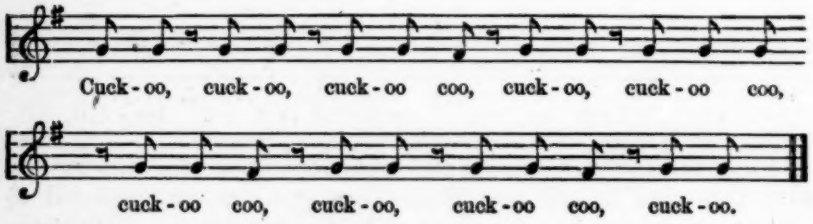
The black and white dress of the grossbeak, his breast adorned with a brilliant rose star, instantly attracts the eye, and his loud, ringing song as surely arrests the ear. He sings rapidly and energetically, as if in a hurry to be through and off. No bird sings with more ardor. While on paper his song resembles the robin's, and the key of E flat major and its relative minor are

common to both, the voice and delivery are very unlike the robin's:

I am told that this bird has also a very musical whistling call.

I found the grossbeaks in Belknap County, N. H., in June, 1886, and in St. Lawrence County, N. Y., in June, 1887.

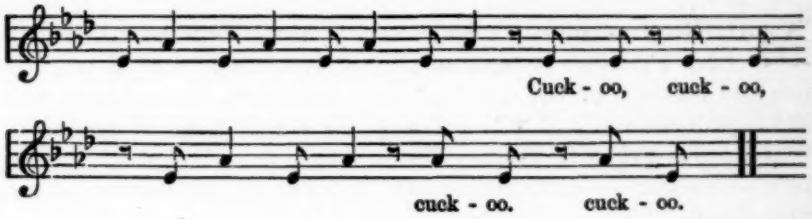
In their fall migrations they go in flocks, occasionally calling upon the farmers for food, appearing as tame and as much at home as if they had been raised by them. Flocks have passed through northern New Hampshire on their journey south in December, paying leisurely visits to the cider mills for the apple seeds in the cast-off pomace, apparently very little concerned about the cold.

BLACK-BILLED CUCKOO.—It is the black-billed cuckoo whose song, with very little merit, has become famous. It must be the low pitch, the solemn manner of delivery, and the quality of tone, that have attracted the attention of the writers; for there is little variety in the rhythm and the least possible in the melody. The rather doleful, straightforward repetition of the singer's name is not heard every day; the cuckoo, too, has his moods.



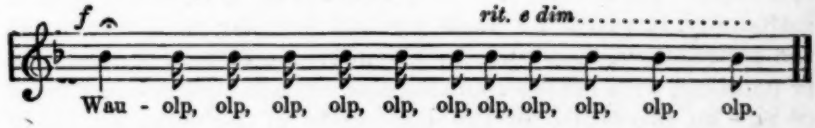
I have heard this bird nearly every summer of my life, and never any departure from the old, monotonous strain, until recently (1888). Early one June morning, sultry and warm, a bird was exercising his voice in a manner that set me on the alert; it was the voice of a cuckoo, but not the cuckoo's song:

At first thought, it was some bird that had practiced under a cuckoo master. It was an anxious moment, but presently all was settled:



The instant I heard "cuckoo," more especially the second one, giving the interval of a fourth, I experienced a thrill of satisfaction such as no similar discovery had afforded. Other ears, sharper than mine, had heard all, unknown to me, and there was great rejoicing; the cuckoo was learning to sing.

YELLOW-BILLED CUCKOO.—The yellow-billed cuckoo, though he tries hard to make a showing of vocal talent, succeeds only in producing a slovenly, guttural blubbering, with barely tone enough to give positive pitch. The beginning of this effort is a sepulchral and somewhat protracted sound, which bursts into several rapid, boisterous bubbles, followed by others softer and slower, farther and farther apart:



The yellow-breasted chat exhibits the same rhythmic peculiarity in his chattings, and so does the woodpecker, drumming on a board or dry limb for the mere sound of it; but in quality nothing can be compared with this slopping performance, unless it be that of the loose-mouthed hound lapping from a pan of milk.

The cuckoos, graceful, beautiful birds, and ever rapt in solemn reverie, are solitary voices, seldom heard more than one at a time.

OBSERVATIONS carried on for nearly two years at the observatories of Berlin, Potsdam, and Prague indicate the existence of a periodical oscillation in latitude. The maximum occurs in summer, the minimum in winter, and the amount is 0′ 25″. The observations have been conducted with the greatest exactitude, and the results of the three sets are concordant. M. Gaillot has communicated a similar result from observations taken at Paris between 1856 and 1861. The variation may be ascribed to a periodical displacement of the earth's axis, in which case, while the amplitude of the phenomena will be the same at all stations, the times of maxima and minima will vary with the longitude; or it may be an effect due to refraction, in which case the periods will be the same at all the stations.

SKETCH OF NICOLAUS COPERNICUS.

MODERN astronomy may be said to have begun with Copernicus. Previous to his time the received theories of the structure and motions of the universe were incorrect, inconsistent, and incomprehensible, and did not explain the inexact observations that were referred to them. He gave to science a correct theory, in which exact observations have found clear and consistent explanations.

NICOLAUS KOPERNIK was born in Thorn, now in Prussia, but at that time a part of Poland, February 18, 1473, and died May 24, 1543. The accounts vary concerning the station of his family. According to the one which seems best established, his father was a native of Cracow, the son of a man in good position there, and had settled as a wholesale trader in Thorn; his mother, Barbel von Wasselrode, was a sister of a Bishop of Ermeland. His earlier instruction, given him in the school at Thorn, included Greek and Latin letters. He then went, under the patronage of his uncle Lukas, who afterward became bishop, to the University of Cracow, where he applied himself to philosophy and medicine, but more ardently than to either of these branches, under the inspiration of the lessons of Albert Brudzewki, to mathematics and astronomy, in which he made himself familiar with the use of the instruments. He also, in his intervals of leisure, practiced in painting, with considerable success. When twenty-three years of age he proceeded to the University of Bologna, where he attended the lectures of Dominico Maria Novarra in astronomy, and formed a personal friendship with him; and then to Padua, where he studied mathematics and astronomy, and obtained the degree of Doctor of Medicine. In 1499 and 1500 he was in Rome, the associate of the astronomer Regiomontanus, and lecturing on the science to a numerous class. He then returned to his native land, where his reputation for learning and his gentle bearing gained him a cordial welcome. He became a priest, and, under the patronage of his episcopal uncle, a canon of Frauenburg, on the banks of the Vistula. Here, from 1503, he spent the remainder of his life, dividing his time between the duties of his profession, works of charity, and the study of astronomy. He visited the poor and sick, gave them medical attention, and relieved their wants at his own expense; devised a hydraulic system for the distribution of water through the city, remains of which are still to be seen; and composed a treatise on the coinage of money, which was preserved in the archives of the Diet of Grodno. The house which he occupied at Allenstein still stands there, or did

very recently, with the holes which he made in the walls of his room in order to observe the passage of the stars across the meridian.

His position here was not, however, one of uninterrupted peace. It fell to him more than once to administer the affairs of the bishopric during a vacancy, and he was charged with the duty of defending the rights and privileges of the see against the Teutonic Knights, who were then very strong. These positions, says M. Biot in the Biographie Universelle, demanded probity and courage. "Copernicus let himself neither be dazzled by the authority of the Knights nor intimidated by their threats. If we repeat these details, which appear foreign to his glory, it is to show that in his character the taste for study and contemplation were united with firmness and constancy—qualities not less necessary than genius for attacking and overthrowing prejudices that had been consecrated by the faith of centuries."

Copernicus lived at the time of the awakening of knowledge, and was a part of it. The idea that the earth moved around the sun was not new; it had been uttered before, but, like many other thoughts that had been expressed among the ancients and then slumbered through the middle ages, it, being contrary to the received notions, was frowned on by authority and was refused a hearing. Copernicus saw, what an intelligent observer could not fail to see, that none of the systems then known could account for the motions of the stars. He had met the most distinguished astronomers of his own time. He was acquainted with all the systems of the ancients; and the more he examined them the more he was astonished at the want of harmony and inconsistency that marked them. "I then took pains," he says, "to read again all the books of philosophy that I could get, to assure myself whether I could find any different opinions from those which were taught in the schools concerning the motions of the spheres of the world. And I saw first in Cicero that Nicetas had expressed the opinion that the earth moves. Then I found in Plutarch that others had had the same idea. . . . Further, the leading Pythagoreans, Archytas of Tarentum, Heraclides of Pontus, Echrecrates, etc., taught the same doctrine, according to which the earth is not motionless in the center of the world, but turns in a circle, and is far from holding the first rank among the heavenly bodies." Pythagoras had learned the same doctrine; Timæus of Locris was very precise in announcing it, when he called the five planets the "organs of time on account of their revolutions," and added that we should have to suppose that the earth was not immovable in the same place, but that it turned around itself and was also carried along in space. Plutarch says that Plato, who had always taught that the sun turned around the earth, changed his opinion

toward the end of his life, and regretted that he had not placed the sun at the center of the world, the only place that became it. Three centuries before Christ Aristarchus of Samos, according to Archimedes, composed a work, now lost, defending the doctrine of the movement of the earth against the opinions of philosophers to the contrary, in which he said that "the sun continues immovable and the earth moves around the sun, describing a circular course of which that star occupies the center." Passing to the Romans, this system of Aristarchus was modified into one like that of Tycho Brahe.

In his review of the ancient systems, Copernicus was most drawn, according to M. Biot, "to that of the Egyptians, which made Mercury and Venus revolve round the sun, and put Mars, Jupiter, Saturn, and the sun in motion round the earth; and to that of Apollonius of Perga, which made the sun the common center of all the planetary motions, while the sun itself revolved around the earth—an arrangement that became the system of Tycho Brahe. Copernicus was impressed with these systems because he found that they represented well the limited excursions of Mars and Venus around the sun, explaining their movements, direct, stationary, and retrograde, an advantage which the system of Apollonius extended to the superior planets. The astronomical planets were thus no longer simple sports of the imagination to him. He had studied them experimentally, and had found the conditions which they must satisfy. The hardest part of his discovery was made. On the other hand, he perceived that the Pythagoreans had taken away the earth from the center of the world and put the sun there. It seemed to him that Apollonius's system would be simpler and more symmetrical if it was modified in this sense, so as to suppose the sun fixed in the center, and the earth revolving round it. He had seen also that Nicetas, Heraclides, and other philosophers, while they placed the earth in the center of the world, had ventured to give it a movement of rotation upon itself, producing the phenomena of the rising and setting of the stars and the alternations of day and night. He still more approved the theory of Philolaus, who, taking the earth away from the center of the world, had given it a rotation on its axis and another motion of annual revolution around the sun. And, although it might seem difficult and even absurd to take the earth from the center and make a simple planet of it, yet, as other astronomers before him had taken the liberty of imagining circles in the sky to explain phenomena, he thought he might be permitted to look for some other arrangement, with a moving earth, which would establish a more simple order in the motions of the stars. Thus, taking what is true from each system and rejecting all in them that was false and complicated, he composed that ad-

mirable whole which we call the system of Copernicus, and which is really only the correct arrangement of the planetary system to which we belong." "After long researches," Copernicus himself said, "I am convinced that if we refer the motions of the other planets to the revolution of the earth, calculation will agree well with observation. . . . I do not doubt that mathematicians will be of my opinion, if they will take the pains to make themselves acquainted, not superficially but profoundly, with the demonstration which I shall present in this book."

He reasoned that "every displacement manifest to our view proceeds either from the object perceived or from the subject which perceives, or from the unequal motions of the two, for an equal and simultaneous motion of the object and the subject could cause no semblance of displacement. The earth is the place whence the movement of the sky is presented to our view. Every motion starting from the earth is reflected in the sky, which will appear to move in the opposite direction. Such is the diurnal revolution, which appears to involve the whole universe except the earth. If now we suppose that the sky has none of this motion, but that the earth turns around itself from west to east (in a contrary direction from the apparent motion of the sky), we shall find that it is really so." Among the chief arguments in support of this view, the astronomer insisted especially on the immensity of the sky as compared with the size of the earth. "The whole mass of the earth," he said, "vanishes before the grandeur of the sky; the horizon divides the celestial sphere into halves, which could not be if the earth bore any proportion to the extent of the sky, or if its distance from the center of the universe was perceptible. Compared to the sky, the earth is only a point; it is as a finite quantity compared with an infinite quantity. It is no more admissible to suppose the earth resting in the center of the universe. What! to believe that immensity turns every twenty-four hours around an insignificancy!" So the inequalities in the movements of the planets—their forward and backward movements and stationary positions—were referred to two causes: the movement of translation of the earth and the proper motions of the planets; correctly, as modern astronomers explain them, only Copernicus was not able to give details and exact figures.

Ptolemy had argued against the idea of these motions of the earth, because if the earth were translated through space it would leave all the loose things on it behind; and, if it turned on its axis from west to east, it would be impossible for bodies to make any headway to the eastward, for, whatever the rate of their motion, the earth would always reach a given point in that direction first. Hence the former idea was the most ridiculous of all (*πάντων γελοιότατα*), and the latter altogether ridiculous (*πάνυ γελοιότατον*). These

arguments seemed unanswerable, and had been received, with Ptolemy's theory, till they had become almost an article of faith. It required a courage which we can only weakly comprehend at this day for a student to fly in the face of the world, of science and religion, and take the solar system to pieces, to put it together again, and to say, after all, that it is the earth which moves and not the sun. Copernicus was slow in venturing before the public with his theory. He began the formulation of his system in 1507; but he wisely determined to make thorough work of the matter, and publish nothing that he could not support with carefully considered argument and evidence. He would not be satisfied with reconciling general appearances with his theory; he would go into details and show how it fitted individual phenomena. He would show how all the movements of the heavenly bodies could be accounted for and predicted by it; even how those phenomena which had hitherto proved unaccountable, the stationary positions and retrograde motions of the planets, and the precession of the equinoxes, found explanation in it. In the mean time reports had got into circulation respecting his new theory, and the public wanted to know what it was. Astronomers were waiting for it, and he was urged to publish it. But he delayed, revising his sheets daily for the insertion of corrected data, and adding new results; and he shrank from the inevitable conflict with the prejudices of the day. These prejudices were already beginning to make their mark. Men of science could accept his views or give them utterance, so far as they had been made acquainted with them, but the general public was against them. He was ridiculed in a comedy; but his gravity and self-restraint carried him safely through all these trials. At last he permitted his friends to publish the work, which he dedicated, in deprecation of clerical censure, to Pope Paul III, in order, as he said in the dedication, that no one should accuse him of running away from the judgment of enlightened men, and that the authority of his Holiness, if he should approve the work, might secure him against the stings of calumny. "I believe," he also said, "that as soon as what I have written in this book concerning the motions of the earth is known, a cry of shame will be raised against me. I am, further, not so much in love with my ideas as to be careless of what others might think about them. And, although the thoughts of the philosopher differ from the aims of the crowd, because he proposes to seek for the truth, so far as God has given it to human wisdom to do, I am not yet ready to reject entirely opinions which seem to be at variance with mine. . . . All these motives, together with the fear of becoming—on account of novelty and apparent absurdity—an object of ridicule, had nearly caused me to renounce the enterprise. But some friends—among them Cardinal Schom-

berg and Tidium Gisius, Bishop of Kulm—succeeded in overcoming my repugnance. The last, especially, insisted most earnestly on my publishing this book, which I had kept on the shelf, not nine years, but nearly thirty-six."

The book (*De Revolutionibus Orbium Cœlestium*) was printed at Nuremberg, under the care of Rheticus, one of Copernicus's pupils, in 1543. Although Copernicus had till that time been enjoying excellent health, he had then been attacked by a dysentery; and this had passed into a paralysis, with loss of his mental faculties, when the first copy of the book was given to him only a few hours before his death. He saw it and handled it, but was too far gone to exhibit any signs of appreciation of it, or for his friends to be able to know how he was affected by it, or whether he realized what it was. The first edition of the *De Revolutionibus*, which is now very rare, was followed by a second edition in 1566, and a third in 1617. Seventy-three years after the death of its author, on the 5th of March, 1616, it was condemned by the Congregation of the Index "for containing ideas set forth as true on the positions and motions of the earth entirely contrary to the Holy Scripture."

The first work recording the labors of the astronomer was the letter published by Rheticus under the title *Ad Clar. V. de Jo. Schonerum de Libris Revolutionum eruditiss, Viri et Mathematici excellentiss. Rev. Doctoris Nicolai Copernici Torunnæi, Canonici Varmiensis, per quemdam juvenem Mathematicæ studiosum, Narratio prima*, Dantzic, 1540; reprinted, with a eulogium, at Basle, 1541. The works of Copernicus are *De Revolutionibus Orbium Cœlestium Libri VI*, Nuremberg, 1543; reprinted at Basle in 1566, with the letter of Rheticus, and also included in the *Astronomia Instaurata* of Nicolas Muller, Amsterdam, 1617 and 1640; a treatise on Trigonometry, with tables of sines, entitled *De Lateribus et Angulis Triangulorum*, Wittenberg; *Theophylacti Scholastici Simocattæ Epistolæ morales, rurales, et amatoriæ, cum Versione Latina.* There are also the treatise on money, already mentioned, and several manuscript treatises in the library of the bishopric of Wiarmia.

The tomb of Copernicus, which was exactly like those of the other canons of Frauenburg, was adorned with a Latin epitaph by the Polish Bishop Cromer, in 1581. It was repaired by Napoleon I in 1807, and so placed that it could be seen from all parts of the church. A statue of Copernicus by Thorwaldsen was erected by subscriptions from the Polish people, in 1829, in the Casimir Palace at Warsaw. The Polish clergy, invited to attend the ceremonies, refused, because his book had been condemned by the Holy Office in 1616. Another monument to him, by Tieck, was erected at Thorn in 1853.

CORRESPONDENCE.

FEET-WASHING AND FEET-KISSING.

IN his article on Greeting by Gesture, in The Popular Science Monthly for February, Colonel Garrick Mallery gave some three pages to the usages in respect to kissing, and said among other things, "Some religious sects—e. g., the Dunkers—also kiss one another's feet—after washing them."

The following note has been sent us respecting this statement.

Editor Popular Science Monthly:

MY DEAR SIR: In the Chicago Tribune of January 31st, I notice an article from your periodical, entitled Kissing has a History. In it occurs the following: "Dunkers also kiss one another's feet when they have washed them." Your historian lacks information, both on the teachings of the Bible and the practice of the Tunker Church, which follows strictly the instructions of the former. I have been a member of the Tunker Church over thirty-five years, and have many times taken part in the Bible command, "Wash one another's feet" (John, xiii, 14), and the injunction, "Salute one another with a holy kiss"; but I never saw them "kiss one another's feet," as your historian states. I send you herewith a proof of an article found in our own Church Almanac for 1891. It will give you and your people some idea of our people. I shall be pleased to make a correction if you feel so disposed. Hoping that I may not be misunderstood, I remain,

Yours truly,

J. G. ROGER,
Professor of Mental and Moral Science,
Mount Morris College.

The article mentioned in the note is an account of the history, doctrine, and usages of the Brethren or Dunkers, compiled by Mr. D. L. Miller. It says, concerning the particular point to which attention is turned:

"The love-feast, which they believe to be patterned after the Supper of the Lord, is a full meal, prepared and placed upon the table used for that purpose in the church, and is partaken by all the members to the satisfying of hunger. It is preceded by the religious rite of washing feet—a service emblematical, as originally described in John, xiii, of the equality of all the members in service, and "bears no more relation to personal cleanliness than the act of baptism does to a bath . . . In its practice, at the love-feast occasions, water is poured into a basin, and a towel or apron is girded about the brother, and, from the example given by Christ, he typically washes his brother's bared feet, as an evidence that he is his servant, and the other his master. The relations are then reversed, and the servant then becomes the master. . . . The sisters wash the sisters' feet, and all the proprieties of the sexes are most rigidly observed. After observing the ceremony of feet-washing, a blessing is asked upon the simple meal spread on the tables, and it is eaten with solemnity. . . . At the conclusion of the meal thanks are returned, and then, as the members are seated around the tables, the right hand of fellowship and the kiss of charity are given. The salutation of the kiss of love in worship and in customary greetings, as enjoined by the apostle, is never observed between the sexes."

The administration of the communion follows.

Colonel Mallery, to whom we sent Prof. Roger's letter and inclosure, explains that his reference to the Dunkers was a merely incidental illustration of the principles he was setting forth in his article. It is a matter of his recollection, his early life having been passed in Philadelphia, now including Germantown—places which are mentioned in Mr. Miller's paper as the earliest American seats of the Dunkers. He distinctly remembers having heard the practice spoken of more than forty years ago by persons who witnessed the ceremony.

"Though our correspondent," he says, "has not heard of kissing the feet in connection with their ceremonial washing among the Dunkers during the thirty-five years in which he has been connected with them, that does not prove that the kissing part of the ceremony was not practiced forty years ago, and that it has not continued later in parts of the country with which he has not been familiar. The Dunkers, popularly known also by other titles, have probably not long enjoined a ritual so immutable and distinct that it could not be varied at their scattered seats by the influence of tradition or individual taste. We have been informed by a frequent visitor to Germantown, Pa., before 1847, that foot-kissing was then and there commonly reported to be practiced among the Dunkers; we are also furnished with the statement of a resident of Allentown, Pa., that he witnessed that performance by them.

"It would be strange if foot-kissing as a

further exhibition of brotherly love had not survived with the foot-washing into this century, through such regions as Pennsylvania, to which the Dunkers had very early brought the Old World rites. Anciently in the Roman Catholic Church, when foot-washing was regularly performed on Maunday or Holy Thursday, the officiating priest kissed the feet that he had washed. Though in the Catholic countries where foot-washing is still observed, their kissing has perhaps generally ceased, it continued even among English Protestants until the time of Queen Elizabeth. An elaborate account of it in 1572 appears in Brand's Popular Antiquities, vol. i, p. 145 *et seq.* (Bohn's edition), in which the kissing of the feet is twice mentioned. It is also specified in Cavendish's Life of Wolsey as practiced by the cardinal in 1530."

After preparing the above statement, Colonel Mallery received two further accounts of kissing in connection with feet-washing among the Dunkers; one was from Philadelphia by an eye-witness, who thoroughly bears out his own statement and recollection. He has also been told by a gentleman from St. Louis, who called upon him, that on the last Holy Thursday, March 26th, the kissing of feet in connection with the foot-washing ceremony was performed there by the Roman Catholic archbishop, and that there were full accounts of that kissing in the papers of the next day. It is really curious, Colonel Mallery adds—and more is in the matter than he at first thought—that in parts of the United States the ceremony goes on in 1891 as a histrionic presentment of traditions generally abandoned.

EDITOR'S TABLE.

LIBERTY AND CIVILIZATION.

IF argument can avail aught in the practical direction of events, the volume lately published under the title of A Plea for Liberty ought to exert a powerful influence upon the politics of our day in so far as they are occupied with questions of social reform. The book is packed with well-digested information and solid reasoning, and no one can fail to derive from its perusal a clearer and wider comprehension of the social problem in its various aspects. The great question which continually presents itself, whatever department of social work we turn to, is, Shall we attempt to hasten improvement by legislation, or shall we trust to the resources of freely acting individuals to modify things in their own interest and to their own advantage? Sometimes, no doubt, legislation, national or municipal, is our only recourse; but the teaching of the book before us is that this recourse has been had in a multitude of cases in which the problem would have been far better solved by individual initiative and action. Another point which is well brought out is that philanthropy in the great majority of cases misses its aim; it wishes to do good, and it does mischief, just reversing the procedure of that ancient prophet who tried to curse, but found himself blessing against his will.

The general issue before the world at the present moment is a very serious one. Mr. Spencer has well expressed it when he entitles his introductory essay From Freedom to Bondage. There is an undoubted danger lest, as he says, those structures in the body politic which make for regulation should gain such a development and such a preponderance as to leave but an insignificant measure of freedom to the social units, and thus, by cramping their activities, fatally impair their energies. We know what a torpor has crept over the Eastern nations through the stereotyping of customs and institutions multiplied beyond all reason. Some one will perhaps say: "Shall we not always remain a free people, with power to change our institutions if they become burdensome? And what does it matter who does social work so long as it is done?" Both questions deserve answer. An institu-

tion may be burdensome and hurtful without being felt to be so; or, if felt to be so, the feeling may not be sufficiently acute to prompt to the action necessary to obtain a change; or, again, the feeling, though more or less acute, may not be accompanied by a sense of power to make the change. Look at individuals. Does every individual who theoretically possesses the power to alter his mode of life to his own advantage put that power into exercise? Does every individual who is shown a more excellent way at once shake off ancient habit and enter on the better path? We all know the enormous influence which procrastination, inertness, love of ease, and prejudice in favor of what is established exert on individual lives; and even so is it with society. There is salvation for the individual at given moments, at special conjunctions, at certain partings of the ways; but, the favorable opportunity missed, the situation becomes more difficult and hopeless with every hour. In social matters the civilized world has been going wrong for years past, and is now threatened with a vast increase of the tyrannical legislation which it has been inviting. It may not be too late yet, however, to make a stand, and perhaps to reverse the current of change. The object of A Plea for Liberty is to force reflection on the subject, and, if possible, to dispel the illusion under which so many have fallen that legislation alone, the action of the state, can make a way for us out of our social difficulties.

Mr. Spencer lays stress on the fact that, in many departments of life, without the intervention of government, progress is being made every day toward a better state of things. There is a power of self-adjustment in individuals which, if not artificially checked, makes infallibly toward better conditions. Elsewhere in the volume we are shown the drawbacks that more or less attend all corporate action, but which in a very marked manner attend the action of the most comprehensive and potent corporation of all—the state; and thus are furnished with an answer to the second question, which a few moments ago we were supposing to be asked: What does it matter who discharges any particular function, so long as it is discharged? If it can be shown that, within the whole radius of state-directed activity, there is a diminution of the motives that give to labor and effort their highest efficiency, then it matters a great deal whether individuals are acting freely as individuals in full contact with a natural environment or whether they are replaced by a host of state-paid employés, dragging on in a lazy and intermittent fashion a lumbering governmental machine. Nothing is more capable of demonstration than that government work is, in general, done in a more or less inefficient and perfunctory manner, and always in a wasteful manner. The natural conclusion to draw from this fact would be that the functions of government should be curtailed as much as possible, so that we might have as little as possible of such inferior and expensive work. Unfortunately, this conclusion is drawn by but few. The results of government work are visible and tangible. They are manifest in buildings, harbors, vessels, blue-books, and people are imposed upon by the scale of the operations of the state. They do not ask how much greater or better results the money expended might have yielded; still less do they ask how much of private enterprise has been paralyzed by an unnecessary extension of the functions of the state. But these questions should be asked, and it is the merest unthrift not to ask them. Of all the printing done by the Government in this country, for example, how much serves a really useful purpose? How much finds its way to the junk-shop, and thence to the paper-mill? If accurate answers could be had to these questions, we think that even an indifferent public might be aroused.

One of the best essays in the volume

we are discussing is that contributed by the editor, Mr. Thomas Mackay, on Investment. In a certain sense it may be said to cover the whole ground; for it deals in the most exhaustive and logical manner with the pretension put forward by socialists that all capital should be vested in the state and used by it for the general good. It shows that as an investor of capital the state is conspicuously incompetent, and that this is so from the very nature of the case. We are tempted to reproduce Mr. Mackay's terse and vigorous statement of his own position: "We argue that capital should belong to him who has earned it, that he alone can make the best use of it, and that he alone should suffer if it is allowed to disappear in ill-considered ventures, or to waste away more rapidly than is necessary for want of due reparation and care; further, that the right of bequest and inheritance is the most economical as well as the most equitable method for the devolution of property from one generation to another; and that the socialist ideal of the universal usefulness of capital, which is our ideal also, can be reached by an ever-widening extension of private ownership and by that means only." This is a succinct and to us refreshing statement of the individualist position; but Mr. Mackay is careful to add that he has no "superstitious respect for the laws which guarantee to owners too extended an authority over their property"; and he lays down what seems to us a useful definition when he says that "the rights of property are those which the mutual forbearance of the members of society finds convenient and indispensable." He thinks that matters in which the courts of law now intervene could be better settled by the parties out of court, and that a certain curtailment in the number of actionable cases might well be made. "In an atmosphere of liberty human character," he declares, "has an adaptability which will prove equal to all occasions." What he desiderates is a "character saturated with the motives of the free life, and in the conviction realized by experience, sanctioned by free choice and made instinctive by custom, that the free interchange of mutual service and mutual forbearance is the beneficent and yet attainable principle on which the well-being of society depends." These, however, are mere expressions of opinion, and Mr. Mackay does not put them forward without bringing facts to their support. His criticism of the state as an investor of the people's money will be found most searching; at the same time he frankly admits that the constantly recurring scandals which mark national and municipal administration are due, "not so much to the incapacity of vestrydom as to the impossible duties for which it is held responsible." He believes (with Henry George) that the legal restrictions on the liquor-traffic have impeded the growth of temperance, and he gives his reasons which we can not here reproduce. Of capital philanthropically employed, he says very tersely that "its usefulness varies inversely as its philanthropy"; and this opinion, too, is backed by cogent reasons drawn from actual experience. Long ago the world's greatest dramatist said, in a passage which Mr. Spencer has most effectively quoted in his First Principles,

> "Nature is made better by no mean,
> But Nature makes that mean."

We may apply this somewhat differently from what Mr. Spencer has done, and say that Nature can not be bettered by any mean that is not itself *natural;* and it is because so much philanthropy is against Nature—actually intended to check and antagonize the working of natural laws—that it so signally and lamentably fails of any useful effect, and tends rather to aggravate social evils. The laws of the universe are more beneficent than we sometimes take them to be, even the law of natural selection which is so often railed against as cruel.

We sincerely hope that the gospel of liberty, preached by Mill in his celebrated essay, and now preached anew, with a vastly enlarged array of proofs in the book to which we have called attention, will gain the ear of the world and rescue its civilization.

LITERARY NOTICES.

THE AUTOBIOGRAPHY OF THE EARTH. By Rev. H. N. HUTCHINSON, F. G. S. New York: D. Appleton & Co. Pp. 290. Price, $1.50.

THOSE who know but little of the science that deals with rock-formations, and regard it as one of many perplexing 'ologies, would be surprised to see what a fascinating story the earth's geological record becomes, as told in this book. The author has not written a text-book, but a volume designed to give the general reader an understanding of the process that has molded the superficial layers of the earth's crust into the forms they bear to-day. In his preface he says: "Many a sportsman or pedestrian, we believe, pauses now and again to examine some curious stone which attracts his attention, or looks at the rock or bowlder on which he rests for a mid-day repast, and would like to understand a little of its previous history. But, not knowing where to turn for assistance, he remains ignorant of a subject of which even a slight knowledge would greatly add to the pleasure of his rambles over the country." The author states that the plan of his book is, "First, to give in simple language, and in a style which it is hoped will not deter the reader, a brief sketch of the former history of our planet, beginning with its first appearance as a member of the solar system, and passing through all the different geological periods, with their changing scenes and various phases of life, down to the latest period, when man appeared on the scene. Secondly, to explain, however briefly, the methods by which the conclusions of geologists have been arrived at, or, in other words, to put the evidence before the reader so that he may see how those conclusions were formed, and judge for himself how far they are reasonable. To do this at all fully in a small book was of course impossible, but it was thought better to attempt brief explanations than to state conclusions which, without reasons, might seem very arbitrary. Such as are given may in some cases be inadequate or incomplete, but at least they will serve to give the reader an insight into the methods of geology, and may possibly lead some to further study, and especially to personal observation. Geology can not be learned from books alone. Observation and a little reflection will help the student far more than reading. Study should be combined with field work, and in this way only can the subject be mastered." It is now fully recognized that the culture demanded by modern life includes an acquaintance with the chief fields of science. This book introduces the reader into one of these fields in a notably happy manner.

A MOVE FOR BETTER ROADS. Essays on Road-making and Maintenance and Road Laws. Philadelphia: H. C. Baird & Co. Pp. 319. Price, $2.

IMPORTANT work in the cause of road-improvement has been done in the preparation and publishing of this volume. The essays which it contains were written in competition for prizes of four hundred, two hundred, and one hundred dollars, offered by William H. Rhawn and other citizens of Philadelphia, and awarded by a board of adjudicators appointed by Dr. William Pepper, Provost of the University of Pennsylvania. The paper for which the first prize was given was written by Henry Irwin, B. A., C. E., of Montreal, assistant engineer on the Canadian Pacific Railway. As required by the conditions of competition, this essay takes up the engineering, the economic, and the legislative features of road-making. The writer gives hints as to locating roads, states what grades are allowable, what widths are required in various cases, and discusses all the other details of construction. One thing on which he lays much stress is drainage. "It is almost impossible," he says, "to make a good road on a wet, yielding soil, except by going to great expense in providing a heavy concrete foundation. . . . In northern latitudes the remark is frequently made in the spring that 'the frost has heaved the road.'" Mr. Irwin says that "the proper remark to make in such a case would be, 'The road is badly drained,'" and he recom-

mends that all roads should have a ditch about four feet deep on each side, outside the fences. In particularly wet places the road-bed should be thoroughly subdrained. For use in cities he names asphalt, stone blocks, wooden blocks, and brick as suitable pavements, giving the advantages and disadvantages of each. He states that a concrete foundation, which need not be very rich in cement, should be provided for any of these. For country roads Mr. Irwin is convinced that the Telford-Macadam system is by far the best, and he says that it is not much more costly than a sufficiently deep simple Macadam. He then goes on to tell what stone should be chosen for the road-metal, how it should be broken and laid on, and how the surface of the road should be finished. While urging the general use of macadamized roads, he does not omit to tell how gravel and earth roads can be improved. Under the head of maintenance Mr. Irwin touches on cleaning and repairing the surface of roads, and cleaning out drains. Under economic features, he gives figures that show how much loss farmers suffer from bad roads. "A farmer who might send produce into market for two hundred days in the year, using a pair of horses to draw a load of about a ton on a poor gravel road, could, if the road were well macadamized, dispense with one of the horses. Supposing that the horse cost him forty cents per day (including interest on first cost), he would save on this single item eighty dollars per annum." Then there is the wear and tear of wagons and harnesses to be considered, and the loss in the price of produce from not being able to get it into town when it is wanted, or not fast enough, if the roads happen to be deep in mud at that time. From the Engineering News of February 22, 1890, is quoted a "statement made by Captain Brown, manager of Hollywood truck-farm in Virginia, to the effect that a pair of horses can draw fifty-five barrels of produce over the roads on that farm, which are in excellent condition, whereas on the ordinary country roads they can only draw twelve barrels." As to road legislation, Mr. Irwin recommends that control over all public roads and bridges should be given to a council in each county. The council should appoint an engineer, assistants, and clerks, whose tenure of office should be permanent. He also recommends the employment of convicts in cleaning and repairing county roads, or in breaking stone at the jails.

The writer of the second-prize paper, David H. Bergey, B. Sc., M. D., devotes considerable space to general discussion of the subject. His recommendations and statements agree generally with those of Mr. Irwin, though he prefers the Macadam to the Telford road. The third-prize essay, by James B. Olcott, of South Manchester, Conn., is quite similar to the preceding. One thing that he protests against is the putting of a layer of broken stone, by contractors, over the surface of a road for the public to wear it down by the wheels of their vehicles. Five papers that had received honorable mention are also published. The writers of these, without reference to order, are Edwin Satterthwait, President of the Cheltenham and Willow Grove Turnpike, Jenkintown, Pa.; Charles Punchard, of Philadelphia; George B. Fleece, C. E., Memphis, Tenn.; Frank Cawley, B. S., Instructor in Civil Engineering, Swarthmore College; and Francis F. McKenzie, C. E., of Philadelphia. A digest of the main suggestions in the other papers that were submitted, and a review of all the essays by Prof. Lewis M. Haupt, the secretary of the committee that arranged the competition, follow the above. A list of brief rules, published by the Road Improvement Association, of London, is appended. The committee intends to publish also a draft or drafts of a model legislative bill for a road law.

This subject is one which profoundly affects the interests of farmers, and will return ten times as much for money, time, and effort expended on it as the ordinary political schemes which promise to do so much for the farmer in return for his support. The above-described volume should have a wide circulation, and should find a place in every public and school library in our farming communities.

STUDIES IN PSYCHOLOGY. By S. G. BURNEY. Nashville, Tenn: Cumberland Presbyterian Publishing House. Pp. 535.

THE author of this work is Professor of Systematic Theology in Cumberland University, and is author of a book on moral science and some works in theology. The volume contains the substance of his class-lectures,

which were prepared for that particular purpose, and are published only at the solicitation of successive classes of students. The treatise is original in the sense that it embodies the author's own independent thoughts, with free criticisms of the writers of the esoteric school who have preceded him, and from whom he differs widely on several important points. It usually, however, has those in view, and, however freely his own theories may be presented, those of the others are not far away. Among the more important points of difference from other standard works are the endeavor to avoid the perplexity arising from the practice of formally accepting any given analysis of the mind, and then practically disregarding it in attributing to one faculty the functions of another; it rejects the doctrine of complex faculties, complex feelings, and complex action, and opposes to it the principle that these features are all simple, though interdependent; it also rejects the doctrines that consciousness is cognitive; that there are a voluntary consciousness, a latent consciousness, and unconscious influences exercised over the mind by unknown objects; that there is an involuntary attention, and the mind can attend strictly to a multitude of objects at the same time; and of the objectivity of time, space, beauty, and sublimity in the form in which those phenomena are generally stated. It differs from the more common theories concerning identity, memory, and the laws of association or mental suggestion. The doctrine of sensibility is discussed briefly; and the textbook presentation of the will is supplemented by a review of the prominent teachings concerning it of a number of the more popular authors from Augustine to the present time. The study offered in this book is wholly from the interior, the author holding, with all who have treated of the subject prior to the rise of the evolutionist school, that "in mental science the mind deals exclusively with itself, or rather studies itself through the facts given in consciousness." We are not disposed to belittle the value of the esoteric study. It has been well attended to by the authors of the past, to whom Prof. Burney often refers, and whom he often also criticises; but the publications of Spencer, Maudsley, Sully, and Ribot have shown that the study from the outside is even more valuable, and has already furnished a large volume of data essential to a full knowledge of the subject, and competent to answer some of the questions which the esoteric theories still leave open. While the adherents of this school may not accept all the conclusions of the evolutionists, they will find that they can not be ignored, and that no treatise can in this day be considered complete that does not take account of them.

A Short Course of Experiments in Physical Measurements. By Harold Whiting. Part II. Cambridge: John Wilson & Son. Pp. 305.

The present portion of this work, the first part of which has been noticed in the Monthly, is devoted to sound, dynamics, magnetism, and electricity. The measurements relating to sound are merely the conclusion of the subject. Under dynamics are included experiments on the pendulum, the measurement of force, elasticity, and cohesion, and the determination of work done. The measurement of the distance between the poles of a magnet, the deflections of compass needles, and magnetic dip are among the experiments under magnetism. Several methods of measuring electrical currents, electrical resistance, and electro-motive force are given. In the concluding pages there are a few experiments for advanced students in various departments of physics, and the use of certain instruments of precision is described. The volume is illustrated with many diagrams and cuts of apparatus.

Principles of Social Economics. By George Gunton. New York: G. P. Putnam's Sons. Pp. 447. Price, $1.75.

The author divides this treatise into four parts, dealing respectively with the principles of social progress, of economic production, of economic distribution, and of practical statesmanship. He defines social progress as "the movement of society toward the realization of the highest material, intellectual, and moral possibilities in human life," and states that it "consists in a series of changes from a relatively simple to a relatively complex state of social organization." Its cause is "man's con-

scious effort to adapt social institutions to his own needs and desires." Considerable historical matter is cited in support of these views. In Part II, on production, Mr. Gunton criticises various definitions of wealth previously given, and thus defines it himself: "Everything may be regarded as wealth, the utility of which is actualized by human effort." Other topics discussed in this section of the book are the nature of value, relation of demand and supply, prices, cost of production, and the function of money. The author advocates the issuing of money by private enterprise, under government supervision. In the part on economic distribution he discusses various theories in regard to wages, rent, interest, profit, etc. Mr. Gunton regards the *laissez-faire* doctrine as unscientific, claiming that it is not likely to secure the survival of the most fit. In regard to international trade he affirms that protection should offset difference in wages, but should do no more; he argues the superiority of a home market over a foreign, and maintains that "no competition can promote industrial well-being which does not tend to make wealth cheap." The sub-title of the book—"with criticisms on current theories"—is amply justified, for nearly every prominent economist is criticised, from Adam Smith to Blaine.

THE MISSOURI BOTANICAL GARDEN. First Annual Report, 1890. St. Louis. Pp. 165.

THIS volume embodies a record of the founding of the Missouri Botanical Garden and of the Henry Shaw School of Botany. It contains a biographical sketch of Henry Shaw, from which it appears that the idea of laying out a garden first came to him during a visit to England, his native country, in 1851. Preparation of the ground for the garden was begun in 1857. In the same year the assistance of the late Dr. Engelmann, then in Europe, was secured to gather suggestions from foreign botanical gardens, and at about the same time a correspondence was begun with Sir William J. Hooker, whose advice largely influenced the shaping of the institution. Mr. Shaw had retired from business, and during the rest of his life—over thirty years—the development and supervision of this garden was his sole care. An outgrowth of the garden was Tower Grove Park, containing two hundred and seventy-six acres, in which more than twenty thousand trees have been planted, all raised in the arboretum of the garden. This volume contains also Henry Shaw's will conveying the garden to a board of trustees, and providing for its maintenance, and also devising property to Washington University for the establishment of a School of Botany. The will is followed by the inaugural exercises of this school, held on November 6, 1885, a report on the school, made in June, 1890, and the first annual report of the Director of the Botanical Garden, covering the year 1889. The inaugural exercises include an address by William Trelease, Engelmann Professor in the school. There is also the first of a series of annual "flower sermons," and the proceedings at the first annual banquet of the trustees of the garden and their guests, funds for both of which commemorations were provided by the will. The volume is illustrated with many full-page views of buildings and spots in the garden and park, maps of the grounds, and a portrait of Mr. Shaw.

BUILDING-STONE IN NEW YORK. By JOHN C. SMOCK. Bulletin of the New York State Museum. Vol. II, No. 10. Albany: University of the State of New York. Pp. 203.

A LARGE amount of information is contained in this report, embracing the geological position and the composition of the building-stones found in the State of New York, the localities where they are quarried, the extent and nature of their use, their durability, etc. The descriptive notes in regard to quarries are arranged under the two general heads crystalline rocks and fragmental rocks; the former including granites, limestones, and marbles, and the latter comprising slate and a variety of sandstones. Under each kind of rock, each locality where it is quarried receives a paragraph. There is an important chapter on the use of stone in cities, in which is stated the general purposes for which the several kinds of stone are used in each of the cities of the State, names of structures built of each kind being given. Many of the stones here mentioned come from without the State. A report on physical and chemical tests of representative building-stones of New York, by Prof. Francis A. Wilber, is inserted, and

there is a chapter on the durability of stone and the causes of its decay. One reason given for the rapid decay of sandstone in recent years is, that lately much of the stone has been set on edge. A folded map of the State on which the towns where there are quarries are marked accompanies the volume.

CHURCH AND STATE. By COUNT LEO TOLSTOÏ. Boston: Benjamin R. Tucker. Pp. 169.

THIS collection of essays, better than any other, shows in strong light the peculiar logic of the Russian novelist. The subjects discussed are Church and State; Money; Man and Woman, and the Mother.

A remarkable dissertation on the origin and use of money takes up the greater part of the book, and is worth reading only as an abnormal subject is valuable for dissection. At the outset it is unequivocally declared that *money* is the cause of slavery, but this proposition is so obscured in the conclusion that many paragraphs are devoted to proving that slavery results from the compulsion of the unarmed by the armed! These are some of his inimitable ideas: "To say to-day that money does not produce slavery is as correct as it was correct fifty years since to say that serfdom did not produce slavery. . . . To plain people it appears beyond doubt that the immediate cause of the enslavement of some men by others is money. But science, denying this, says that money is only a medium of exchange, which has no connection with the enslavement of men. . . . Doubtless money has those harmless properties which science enumerates; but it has them in reality only . . . in an ideal society, but in such a society money would not exist at all; . . . its main function is not the serving as a medium of exchange, but the serving as a means of compulsion." The proof of this assertion Tolstoï proceeds to find in the history of the Fiji Islands. The Fijians were unacquainted with any means of exchange other than barter until American colonists came among them. Some of the American intruders were injured by Fijians, and the United States Government demanded forty-five thousand dollars indemnity for the outrages. The Fijians appealed to England for protection, borrowed money, and finally became enslaved—*ergo*, money is the cause of slavery!

The scientific method of investigation is somewhat slower than this electric Russian would have it, so he compares it to "a lazy, restive horse," and states at length: "Science has a definite purpose, which it accomplishes. The purpose is, to maintain the superstitions and delusions of the people, and thereby *hinder humanity in its advance toward truth and welfare.*" It is hardly worth while to pursue such folly much further, yet Tolstoï carries this agility of conclusion into his examination of all social questions. In another essay he enunciates the following theorem: 'The service of mankind resolves itself into two parts: 1. The improvement of living men and women. 2. The perpetuation of mankind itself. To the former men are chiefly called, *since the possibility of the latter service is denied them.* To the second women are called, as they are exclusively capacitated therefor." At one time he would make the world a vast nursery where the ideal woman rears the greatest possible number of children; at another he declares, "The continuation of the human race will no longer be necessary for those who are living a true life."

The celebrity of this author makes any utterance from him noticeable; but, however highly his imaginative power may rank him as a novelist, there is no continuity or sequence to his arguments, and as a thinker he is wholly out of joint.

HOUSEHOLD HYGIENE. By MARY TAYLOR BISSELL, M. D. Fact and Theory Papers, No. 7. New York: N. D. C. Hodges. Pp. 83. Price, 75 cents.

WE rarely see a book that hits its aim so pat as this one does. It covers an important subject with a serviceable degree of completeness, it contains nothing that is superfluous or unavailable to those for whom it is written, and it is everywhere clear, forcible, and direct. The author's statement of what she has attempted is no less apt than the body of the book. "This little volume," she says, "has been compiled with the hope that the housekeeper of to-day may find in its pages a few definite and simple suggestions regarding sanitary house-building and housekeeping which will aid her to maintain in her own domain that high degree of intelligent hygiene in whose enforcement lies the physical promise of family life."

Nothing more is needed by way of description but to give the chapter headings; these are: The Site and the Soil; Hygiene in Architecture; The City House and Plumbing; The Country House; Ventilation and Heating; Our Water-supply; Kitchen and Table Hygiene; Sanitary Furniture; The Sick-room; Roof Gardens.

OPEN SESAME! POETRY AND PROSE FOR SCHOOL-DAYS. By BLANCHE WILDER BELLAMY and MAUD WILDER GOODWIN. Vol. III. Boston: Ginn & Co. Pp. 361.

THIS volume, the closing one of the series, is intended for pupils over fourteen years of age, and young students in search of something to read or recite can scarcely fail to be satisfied with its varied contents.

There are rhymes of old-fashioned flavor from Chaucer and Robert Herrick and verses of modern seasoning by Joaquin Miller and Walt Whitman. The shorter masterpieces of English are given, as well as poems culled from Omar Khayyam, Schiller, and Victor Hugo. Famous stirring addresses are chosen from the time of Thucydides and onward, and wise words of counsel from Prof. Huxley and Jane Welch Carlyle.

The selections are grouped under five headings—Sentiment and Story; Art and Nature; Loyalty and Heroism; Song and Laughter; Holidays and Holy Days—and to each section an illustration is prefixed.

The State University of Iowa publishes semi-annually a journal entitled *The Transit*, edited by the Engineering Society in that institution (price, 50 cents). The second issue was that for December, 1890, and is largely devoted to the details of a series of cement tests carried on in the department of engineering. The paper was prepared by Mr. Hubert Remley, one of the authors of the article on cements in the Monthly for March, and is illustrated with diagrams and cuts of apparatus. Besides this, there are two short papers on cements in this issue, and other papers on The Preservation of Timber, A Simple Method of determining Latitude, and on Paving-Brick and Brick Pavements. Two of the university buildings are described, with illustrations, and the issue contains also editorial matter and a list of courses in engineering given by the university.

Two addresses by Prof. *Delos Fall* have been reprinted together from the Report of the Michigan State Board of Health for 1890. One, on *School Hygiene*, urges attention to everything that affects the health of children during school hours. The other is *A Study of the Action of Alcohol on the Human Body*, and presents, without any fanatical ranting, the evils which physiologists say that alcohol inflicts upon the human body. It also quotes General Greely as stating that the regular taking of alcohol is useless, or worse, in very cold regions, and Mr. Stanley as having the same opinion of its use in very hot regions.

Some of the experimental psychological studies of *Alfred Binet* have been published in a pamphlet entitled *On Double Consciousness* (Open Court, 50 cents). An essay on Experimental Psychology in France is prefixed to these studies, in which the special fields are mentioned that the leading psychologists of that country are engaged in, most of these being embraced in the domain of pathological psychology. By double consciousness is meant the capability of hysterical persons to respond to excitations of an insensible part of the body without being aware that the excitation or response has been made. The author describes experiments performed on the insensible arm and the hysterical eye, defends the hypothesis of double consciousness against the theory of unconscious automatic action, and discusses various topics connected with his general subject.

A pamphlet manual of *Invertebrate Dissections* has been published by Prof. *Henry L. Osborn*, of Hamline University, St. Paul, Minn. (price, 40 cents). It tells what parts are to be observed and where to look for them in each specimen. The creatures chosen for dissection are readily obtainable, and include the sponge, various hydroids, coral, star-fish, angle-worm, crayfish, etc., ending with the grasshopper. The author states that the accounts of type specimens contained in this manual are incomplete, and should be supplemented with details of anatomy, embryology, paleontology, etc., gathered from reading or lectures.

A lecture on *Organic Evolution* delivered by Prof. *Samuel E. Tillman* at the United States Military Academy has been printed at

the Academy Press. It presents those general facts concerning evolution in the domain of life that every intelligent person should be acquainted with, and in a manner well calculated to arouse the interest and hold the attention of hearers or readers. This lecture has been pronounced by good judges a most satisfactory summary of the great doctrine with which it deals.

A useful book for the phonetic teaching of reading is *A Sound-English Primer*, by *Augustin Knoflach* (Stechert, 25 cents). Its plan is to teach children first how to read phonetic print, and then, using this knowledge as a stepping-stone, to impart the ability of reading the ordinary spelling. The author's scheme of phonetic spelling recognizes six long and six short vowel-sounds, the long vowels being distinguished by doubling the letters. No new letters are employed; *q*, not being needed as a consonant, is used for the sixth vowel, and six digraphs are used for consonants that have no single letters to represent them, namely, *ch*, *sh*, *zh*, *th*, *dh*, and *ng*. A notable feature of this system is that it indicates accent. In words in which it does not conform to a simple rule, the accent is marked either by a diacritic or by doubling a consonant. Prefixed to the book is an account of a test of this mode of teaching made last summer with a part of Mr. Knoflach's manuscript. In a little over three weeks a six-year-old boy, who had never had any instruction in reading before, was made able to read a large portion of an ordinary primer. Mr. Knoflach's book has clear print and is of convenient size.

No. 3 in the series of pamphlets on North American Fauna, issued by the Department of Agriculture, embraces the *Results of a Biological Survey of the San Francisco Mountain Region and Desert of the Little Colorado, Arizona*, by *C. Hart Merriam* and *Leonhard Stejneger*. It contains a general description of the region and annotated lists of the mammals, birds, reptiles, and batrachians found therein, with a few notes on the forest trees that are common in that locality. The skulls and dentition of many of the animals are figured, and there are also colored maps showing the distribution of forest trees about the mountain.

In an essay on the *Origin of Plane Trees*, reprinted from the American Naturalist, Prof. *Lester F. Ward* criticises a paper by Prof. Johann Jankó on the same subject. Jankó excludes from the genus certain American species that had not before been challenged, and ignores others; but the chief point that Prof. Ward urges against him is that he has overlooked the significance of the basal lobes that occur on the leaves of some species.

Among the results of Prof. *Angelo Heilprin's* study of *the Geology and Paleontology of the Cretaceous Deposits* of Mexico, made during his expedition to that country in the spring of 1890, are the conclusions that the deposits, covering or scattered over a large part of the country, are continuous with the Cretaceous area of the interior basin of the United States; that they are a part of the Middle or Upper Cretaceous series; that no true Lower Cretaceous beds have been so far identified in Texas or Arkansas; and that no marine deposits of unequivocally Lower Cretaceous age have thus far been determined in the United States east of the Rocky Mountains.

Pilot Knob; a Marine Cretaceous Volcano, of which Prof. *Robert P. Hill* has published a study, is one of a group of hills composed of igneous rock standing a few miles southwest of Austin, Texas. From its structure, as studied by the author, it appears to be the neck of an ancient volcano which rose out of and deposited its *débris* in the deep water of the Upper Cretaceous sea. From its isolated position it must have been an isolated eruption. The hill probably belongs to a great chain of igneous localities, eruptive and basaltic, extending from the mountains of northern Mexico to the Ouachita system of Arkansas.

The Account of the Determination of the Mean Density of the Earth by Means of a Pendulum Principle, by *J. Wilsing*, of Potsdam, has been translated and condensed for the Smithsonian Report by *J. Howard Gore*. The value found by Mr. Wilsing is $5{\cdot}579 \pm 0{\cdot}012$.

A second edition, revised and enlarged, is published by Blakiston, Son & Co. of *Leffmann and Beam's Examination of Water for Sanitary and Technical Purposes*. The more recent methods of water analysis may be found in this volume, including those rec-

ommended by the Chemical Section of the American Association for determination of nitrogen in ammonium compounds, for nitrates and nitrites, and for oxygen-consuming power. Attention is called by the authors to the application of the Kjeldahl process in ascertaining the total organic nitrogen. The media and manipulation of biological examinations are amply treated, and a chart is given of the culture phenomena of the more important microbes. Much value is not attached, however, to the results thus obtained, since the number of microbes may vary greatly without analogous variation in the healthful character of the water. Ordinary filtration is shown to increase the micro-organisms, which develop finely in the pores of sand or stone filters. The Bischof and the Pasteur filters are to be preferred for household use, while the Anderson process of agitating the water with fine particles of cast iron in a rotating cylinder produces a water of high organic purity with great rapidity. The text is clear and well arranged, all required apparatus is illustrated, and useful analytical tables are furnished for comparison.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations: Connecticut. Annual Report for 1890. Pp. 207; Bulletin on Milk and Cream. Pp. 14.—Delaware Soil and Crop Tests. Pp. 13; Injurious Insects and Insecticides. Pp. 13.—Kansas State Agricultural College. Oat Smut. Pp. 40.—Massachusetts. Treatment of Fungous Diseases. Pp. 12; Commercial Fertilizers. Pp. 8.—Michigan State Agricultural College. Beet Sugar. By R. Kedzie. Pp. 10; Six Worst Weeds. By W. J. Beal. Pp. 6, with specimens.—New York. Fertilizers. Pp. 20.—Rhode Island. Bees. Pp. 20.—Utah. Potato Trials. Pp. 22.

Allen, Harrison. Description of a New Species of Bat. Smithsonian Institution Pp. 8.

Bedford, P. W., Editor. Pharmaceutical Record. Monthly. New York. Pp. 12.

Bigelow, H. R., M. D. Plain Talks on Electricity and Batteries. Philadelphia: Blakiston. Pp. 85.

Billings, Frank S., M. D. Original Research in Relation to Animal Economics. Philadelphia: American Medical Press Co. Pp. 39.

Branner, J. C. Relations of State and National Geological Surveys. Salem Press, Mass. Pp. 21.

Brinton, Daniel G. The American Race. New York: N. D. C. Hodges. Pp. 392. $2

Brooklyn Ethical Association. Evolution Series: Alfred Russel Wallace. By E. D. Cope. Pp. 17, with Portrait.—Ernst Haeckel. By T. B. Wakeman. Pp. 36, with Portrait.—The Scientific Method. By F. E. Abbot. Pp. 20.—Herbert Spencer's Synthetic Philosophy. By B. F. Underwood. Pp. 40. Appletons. 10 cents each; $2.40 a year.

Camman, D. M. Diagnosis of Diseases of the Heart and Lungs. Putnams. Pp. 178. $1.75.

Capp, W. M., M. D. The Daughter: her Health, etc. Philadelphia: F. A. Davis. Pp. 144. $1.

Catalogues: Chicago Manual Training School. Pp. 32.—Wells College, Aurora, N. Y. Pp. 44.

Davies, Thomas A. Am I Jew or Gentile? New York: E. H. Coffin. Pp. 87. 25 cents.

Detroit Evening News Association. The Quarterly Register of Current History. Vol. I, No. 1. Pp. 84. 25 cents, $1 a year.

Dunbar, Charles S. Chapters on the Theory and History of Banking. Putnams. Pp. 199.

Excelsior Publishing House, New York. The Devil's Visit (poem). Pp. 448. $1.

Gill, Theodore. Note on the Genus Felichthis of Snauison. Pp. 2.

Hale, E. M., M. D. The Condition of the Heart in Pneumonia. Pp. 8.

Hatch, F. H. Introduction to the Study of Petrology. Macmillan. Pp. 128. 90 cents.

Hay, O. P. Anatomy of Amphiuma. Boston: Ginn & Co. Pp. 33, with Plate.

Herrick, F. H. Adelbert College. Notes on the American Lobster. Pp. 16.

Höffding, H. Outlines of Psychology. Translated by M. E. Lowndes. Macmillan. Pp. 365. $1.50.

Hovelaque, M. Ab, and others. Editors. Revue Mensuelle de l'École d'Anthropologie de Paris (Monthly Review of the Anthropological School of Paris). Pp. 32. 1 franc. 10 francs a year.

Illinois State Board of Health. J. H. Rauch, Secretary. Medical Education, etc., in the United States, Canada, and Foreign Countries. Pp. 222.

Jordan, D. S. Fishes obtained in the Harbor of Bahia, Brazil. Smithsonian Institution. Pp. 24.

Lankester, E. Ray, and others. Zoölogical Articles contributed to the Encyclopædia Britannica. Scribners. Pp. 195. $5.

Lucas, F. A. Osteology of the Paridæ, Sitta, and Chamæa. Smithsonian Institution. Pp. 12, with Plate.

Maxwell, W. H. Advanced Lessons in English Grammar. American Book Co. Pp. 327. 60 cents.

Meyer, Annie Nathan. Woman's Work in America. New York: Henry Holt & Co. Pp. 457.

Miller, S. A. Lower Carboniferous Crinoids from Missouri. Jefferson City. Pp. 40, with Plates.

Morrison-Fuller, J. To-day. Weekly. Pp. 16. 5 cents. $1 a year.

Müller, F. Max. Physical Religion. Longmans, Green & Co. Pp. 410.

North, S. N. Dexter, Secretary. Bulletin of the National Association of Woolen Manufacturers. Quarterly. Pp. 104. 50 cents. $2 a year.

Ott, Isaac, M. D. The Modern Antipyretics. Easton, Pa.: E. D. Vogel. Pp. 52.

Palmer, E. R., M. D. Valedictory Address. Louisville, Ky.: J. P. Morton & Co. Pp. 24.

Phillips, J. H., and others. Editors. Educational Exchange. Birmingham, Ala.: Solomon Palmer. Pp. 44.

Quackenbos, John D., and others. Editors. Appletons' School Physics. American Book Co. Pp. 544. $1.20.

Ripley, C. B. Improved Roads. Trenton, N. J. Pp. 58.

Robins, Rev. J. B. Christ and our Country. Dalton, Ga.: Ainsworth Brothers. Pp. 141. 75 cents.

Shoemaker, J. V., M. D. Heredity, Health, and Personal Beauty. Philadelphia: F. A. Davis. Pp. 422. $2.50.

Shufeldt, R. W. Camera Notes for Ornithologists. Pp. 4.

Smith, Roderick H. A New Business in Wall Street. Pp. 85.

Smithsonian Institution. Report for 1888–'89. Washington Pp. 815.

Staunton Development Company. Staunton, Va. Pp. 74, with Plates.

Taylor, Hannis. The Freedom of the Press: Argument in a Lottery Case. Pp. 78.

Whitfield, R. P. Contributions to Invertebrate

Paleontology. New York Academy of Sciences. Pp. 118, with Plates.

Williams, S. T., Detroit. Nickel Savings Stamp System. Pp. 8, with Photographs.

Winslow, Arthur. Biennial Report of the State Geologist of Missouri. Jefferson City. Pp. 53.

POPULAR MISCELLANY.

School of Applied Ethics.—An institution with the above name is to hold its inaugural summer session, at some point on the sea-shore near Boston, during six weeks beginning early in July. The department of economics will be in charge of Prof. H. C. Adams, of the University of Michigan. He will treat of the history of industrial society in England and America; President Andrews, of Brown University, will discourse on the evils of our industrial system, and discuss proposed remedies. Prof. Taussig, of Harvard, will lecture on co-operation; Hon. Carroll D. Wright, on factory legislation; Prof. J. B. Clark, of Smith College, on agrarian questions; Albert Shaw will describe the housing of the poor in London and Paris, and examine General Booth's "Way out." Labor and industrial legislation in Europe will be treated by Prof. E. J. James, of the University of Pennsylvania. Mr. Henry D. Lloyd, of Chicago, is expected to present two chapters in the industrial history of the United States. Prof. C. H. Toy, of Harvard, will have charge of the department of religious history, for which he has enlisted a corps of eminent scientific lecturers. Prof. Felix Adler, of New York, who is the originator of the school, will preside over the department of ethics. His lectures will treat of personal and social ethics; the ethics of the family, the professions, politics, friendship, and religious association. Criminal and temperance legislation, and questions of like importance, are to be presented by other lecturers. The terms for the whole course are but ten dollars. Detailed information may be had from the dean, Prof. H. C. Adams, 1602 Chestnut Street, Philadelphia, Pa.

The Floods of the Amazons.—All the mighty tributaries of the Amazons west of the Madeira and the Rio Negro, according to Dr. P. Ehrenreich, present the same characteristics—viz., a course twisted into innumerable curvings, an uninterrupted navigability over many hundreds of miles, and low banks inundated during a great part of the year by high waters. The forest vegetation is remarkably luxuriant, and the India-rubber plant grows in the utmost profusion. Another characteristic feature of these rivers is the continual change in their course. The high water of the rainy season, exceeding by from fifty to sixty-five feet the low level of the dry season, under-washes the banks; the masses of soil thus detached are again deposited at the next bends of the river, and contribute in diverting the stream from its bed. In this way a labyrinthine system of canals arises, which accompanies the river along its whole course—the so-called *igarapés*. The old bends of the river, half or wholly shut off, form lagoons, which serve as mighty reservoirs and draw off immense quantities of water, so that the *régime* of high waters commences in the lower basin much later than in the upper part of the river. At the head-waters of the river the water-level is wholly dependent upon the rainfall in the Cordilleras; it rises and falls very suddenly, so that it not unfrequently happens that the steamer is obliged to be set right about quickly on account of the falling waters, if indeed it does not become stranded for a long time.

Hypnotism as a Therapeutic Agent.—A discussion of hypnotism as a therapeutic agent was held at a recent meeting of the Islington Medical Society, London, when Mr. Pridgin Teale and other speakers described some phenomena which they had witnessed. They were followed by Sir Andrew Clark, who characterized hypnotism as a "distortion of the partial sight of truth," and predicted that, like mesmerism years ago, it would have its day and follow into desuetude. Seeking for the physiological truth contained in the subject, he looked for the groundwork of many of the phenomena in the relation of will to the body. The communication of the will with the body, he said, brings about wonderful changes in it; and, independently of will, there is the exercise of attention, of expectation, and of concentration; and we know that without the introduction of any foreign agency—that is to say, the agency of any other person—attention, expectation, and concentration of will operating together bring about most remark-

able results in the human body. There are many homely illustrations of this fact—as when one has a headache which disappears on the coming of some unexpected visitor, to return as soon as he is gone, or when a patient is relieved on the administration of a bread-pill. The speaker himself had been so interested in looking at a microscopic object that people had come into his room and spoken to him, and he had not heard or seen them. Looking at these physiological conditions, a great many things can be brought about which are described as being induced by the agency of another person. The speaker estimated the frequency with which such agencies can be made successful as in inverse proportion to the development of the higher ganglia. People are influenced by them in the inverse order of their intellectual faculties, and in the direct order of the automatic activities of the brain; hence the range in which such phenomena are capable of being seen and produced is practically what is called the neurotic range. This includes people whose nervous systems are movable, excitable, sensitive, irritable, or explosive. All such people are capable of manifesting phenomena which are brought about by attention, expectation, and concentration; and we find, too, that all these phenomena occur in people with a lowly developed nervous system, which is to a great extent automatic, and is manifestly enforced by emotion. The hypnotic phenomena which are related were supposed to be capable of explanation on the simple physiological grounds thus laid down, without the introduction of any person exercising a mysterious power.

Scenery of Yellowstone Park. — The merits of the scenery of Yellowstone Park appear to Prof. G. F. Wright to have been considerably exaggerated. He rode through it under favorable conditions for observation, but found his trip, on the whole, disappointing. The figures representing the height of the mountains around it above the sea are deceptive. A mountain 10,000 or 11,000 feet high does not look extraordinarily large and massive when it rises not more than 2,000 or 3,000 feet above the elevated plateau on which it stands as a base; but those 2,000 or 3,000 feet are all that is shown of the mountain-rim of the park, while the glimpses to the outside mountains are few and far between. The grandest views are those on entering the park as one looks outward from the encircling rim. "Those who reside in the Atlantic States do not need to go to the Rocky Mountains for scenery." Even Dr. Hayden acknowledged this substantially after he had been to the Crawford Notch. "He who has seen the Adirondacks and the White Mountains has seen some of the best artistic effects of which Nature is capable. Even he who has looked over the parallel ranges of Pennsylvania has no need to pine for the mountain scenery of the Yellowstone Park." The beauty of the Yellowstone Cañon, however, with its unique combinations of rock-carving and variegated color, which "artists are put to shame in their attempts to imitate," can hardly be surpassed. The geysers, Prof. Wright says, in the Boston Congregationalist, "are decidedly vulgar, and one can afford to die without seeing them. Boiling paint-pots, with only one dull color in them, are not inspiring. Acres of land laid waste by sulphurous waters and gases, such as greet one on every hand in these geyser basins, can be seen at any time in Pennsylvania where the refuse water is pumped from the coal-mines to spread its desolation all around. The Upper Geyser basin, with its score or more of steam-jets, looks from a distance like a flourishing manufacturing town. The odors can be matched in the calico-printing mills. The geysers differ from steam fire-engines in throwing hot water instead of cold; and even the Excelsior is not as impressive as the ocean surf of the New England coast." But the author thinks that the scientific interest of the park can hardly be exaggerated.

Mosquito-inoculation against Yellow Fever.—Statements are made by two physicians of Havana (Drs. Finlay and Delgado), in the medical journal of that city, concerning their practice of inoculating persons newly arrived in Cuba against yellow fever by means of mosquitoes which have been caused to contaminate themselves by stinging a patient afflicted with that disease. The observations have been carried on for ten years, and relate to fifty-two cases of mosquito-in-

oculation which have been followed out, and others which are still incomplete. Of the cases, twelve experienced between the fourth and the twenty-sixth day of inoculation a mild attack of yellow fever; twenty-four experienced no symptoms within twenty-five days, but contracted a mild attack before the end of three years; twelve exhibited no symptoms of the disease within three years; three, who had no symptoms within twenty-five days, contracted well-marked yellow fever within three years; and one, who had a mild attack in consequence of inoculation, contracted a severe attack later on which proved fatal. Thus only eight per cent of those who had been inoculated contracted the disease in a well-marked form, and the mortality was less than two per cent. Of sixty-five monks who came to Havana and lived there under similar conditions, thirty-three were inoculated and thirty-two were not. Only two of those who were inoculated had well-marked attacks, and these were not fatal; while eleven of those who had not been inoculated were severely attacked, and five died. But inoculations performed in cold weather do not seem to be wholly trustworthy and need to be repeated in the spring; also it appears that a person who has been three years in the city without having the disease has become acclimatized, and is not likely to be attacked afterward.

Facts about the Aurora Borealis.—The present condition of the investigation of the phenomena of auroras is thus described by Mr. G. S. Griffiths, F. G. S., F. R. S., in an address on the objects of antarctic exploration. The nature of auroras, the author says, is very obscure; but recently a distinct advance has been made toward discovering some of the laws which regulate them. "Thanks to the labors of Dr. Sophus Tromholt, who has spent a year within the Arctic Circle studying them, we now know that their movements are not as eccentric as they have hitherto appeared to be. He tells us that the aurora borealis, with its crown of many lights, encircles the pole obliquely, and that it has its lower edge suspended above the earth at a height of from fifty to one hundred miles, the mean of eighteen trigonometrical measurements, taken with a base-line of fifty miles, being seventy-five miles. The aurora forms a ring round the pole, which changes its latitude four times a year. At the equinoxes it attains its greatest distance from the pole, and at midsummer and midwinter it approaches it most closely; and it has a zone of maximum intensity which is placed obliquely between the parallels of 60° and 70° north. The length of its meridional excursion varies from year to year, decreasing and increasing through tolerably regular periods, and reaching a maximum about every eleven years, when, also, its appearance simultaneously attains to its greatest brilliancy. Again, it has its regular yearly and daily movements and periods. At the winter solstice it reaches its maximum annual intensity, and it has its daily maximum. . . . Whether or not there is any connection between auroral exhibitions and the weather is a disputed point. Tromholt believes that such a relationship is probable. He says that 'however clear the sky, it always became overcast immediately after a vivid exhibition, and it generally cleared again as quickly.' Payer declares that brilliant auroras are generally succeeded by bad weather, but that those which had a low altitude and little mobility appeared to precede calms. Ross remarks of a particular display that 'it was followed by a fall of snow, as usual.' Scoresby appears to have formed the opinion that there is a relationship indicated by his experience. It is, therefore, allowable to regard the ultimate establishment of some connection between these two phenomena as a possible contingency. If, then, we look at the eleven-year cycle of auroral intensity from the meteorological point of view, it assumes a new interest, for these periods may coincide with the cycles of wet and dry seasons which some meteorologists have deduced from the records of our Australian climate, and the culmination of the one might be related to some equivalent change in the others. For, if a solitary auroral display be followed by a lowered sky, surely a period of continuous auroras might give rise to a period of continuous cloudy weather, with rain and snow. Fritz considers that he has established this eleven-year cycle upon the strength of auroral records extending from 1583 to 1874, and his deductions have been verified by others."

Function of Cypress Knees.—The cypress tree (*Taxodium distichum*) of the Southern swamps is marked by a peculiar growth of protuberances rising above the soil in the region of the roots, and called knees. The purpose of the knees has not been satisfactorily determined. They have been regarded by botanists as simply affording a means for securing the aëration of the sap when the roots are too deeply covered with water to permit them to serve that purpose. Mr. Robert H. Lamborn, after examining the trees in the swamps, has come to a different conclusion. He believes that the knees secure a firm hold to the tree in the exceedingly loose soil in which it grows. The formation of knees is accompanied by roots projecting more or less perpendicularly into the earth. The knee, when fully developed, is generally hollow, comparatively soft, gnarled, and hard to rupture, so that it has the quality of a spring that becomes more rigid as it is extended or compressed out of its normal shape. "When, in a hurricane, the great tree rocks back and forth on its base, and with its immense leverage pulls upon this odd-shaped wooden anchor, instead of straightening out in the soft material, as an ordinary root might, thus allowing the tree to lean over and add its weight to the destructive force of the storm, it grips the sand as the bower-anchor would do, and resists every motion. The elasticity at the point of junction allows one after another of the perpendicular flukes attached to the same shank to come into effective action, so that before being drawn from the sand or ruptured the combined flukes present an enormous resistance." The knees, with their sharp tips, may also serve the purpose of catching the drift of plant-food as it floats on the currents of floods, and effecting its deposition. Mr. Lamborn adds, in his articles in Garden and Forest and the American Naturalist, an observation regarding the roots of other trees that trench upon soils affected by the cypress, and often take advantage of the anchors it sets in treacherous bottoms. They project their cable-like, flexible roots in every direction horizontally, interlacing continually until a fabric is woven on the surface of the soft earth like the tangled web of a gigantic basket. Out of this close wickerwork, firmly attached to it, and dependent for their support upon its integrity, rise the tree trunks. Thus slowly, and by a community of growth and action, a structure is formed that supplies for each tree a means of resisting the storms. Such communities of trees, provided with ordinary roots, advance against and overcome enemies where singly they would perish in the conflict.

The Chigger.—Dr. H. M. Whelpley has published two papers on the chigger (*Leptus irritans*), an insect which is very troublesome to blackberry-pickers in the Mississippi Valley. It has no relation to the chigoe (*Pulex penetrans*) of South America, which resembles the fleas, while this insect is like the ticks. It is found in the Eastern and Southern States as well as in the Mississippi Valley, but has not been reported north of the fortieth degree of latitude, and does not seem to thrive in the far West. Besides human beings, it attacks the house-fly and is very troublesome to young fowls, where the parasites collect in lumps as large as a pin, and cause death, with the symptoms of poisoning by strychnine. Some persons are more susceptible to its attacks than others. Some specimens of the insect are almost transparent, but they all become darker in color as they become gorged with blood. Several remedies are prescribed for the living chiggers and for the sores they cause. Among them are kerosene and spirits of camphor.

Malays and Negritos of Malacca.—In his account before the Anthropological Institute of the races of the Straits Settlement (Malacca), Mr. Swettenham, of the Settlement's Civil Service, assumed that the Malays are not indigenous to the peninsula; but the exact place of their origin has not been established. According to their own traditions, they are of supernatural origin, and crossed over from Sumatra. Until about A. D. 1250 they were pagans or Hindooists, but near that time they came under the influence of Mohammedanism. The Perso-Arabian characters were introduced then, while the language had not previously been written. Relics of Hindoo superstition still exist among the Malays and Negritos of the peninsula, and customs that savor strongly of devil-worship. The author would classify

the Negritos into the Sakai and the Samang. The Sakai are a people of moderate stature and large bones, fairer in complexion than the Malays, with long, wavy hair standing straight out from their heads. The Samang are small and dark, with black, frizzy hair close to their heads, like that of the negro races. Some writers have inferred, from comparison of languages, that there are connecting links between the Negritos of various tribes and the Malays, and believe that the former show traces of Melanesian blood.

Massage in Ancient Times.—Massage has apparently been practiced from the very earliest times. A Chinese manuscript of three thousand years before the Christian era contains an account of operations very similar to those which go under that name at the present time—friction, kneading, manipulating, and rolling. A form of massage was the common accompaniment of the bath with the Egyptians, Greeks, and Romans, and was used as a luxury, a means of hastening tedious convalescence, and of making the limbs supple and enduring. Hippocrates commended it; Esculapius believed in it; Cicero affirmed that he owed as much of his health to his anointer as he did to his physician; Julius Cæsar had himself pinched all over every day for neuralgia; and Pliny enjoyed great benefit from it. Celsus advised rubbing to be applied to the whole body; and the works of Plato abound in references to the use of friction. Peter Henrik Ling is said to have based the Swedish movement-cure on the Chinese Kong-Fan manuscript. Lepage relates that the Chinese massage was a particular practice borrowed from the Indians, and that it was by such means that the Brahmans effected their miraculous cures. The method is common among the Polynesians, and something like it was found among the Australians.

Decay of India Rubber.—Mr. W. Thomson says, in a paper on the vulcanization and decay of India rubber, that copper salts have an injurious effect on India rubber, and, as that metal is sometimes used in dyeing blacks and other colors, cloth so dyed is liable to decompose and harden the rubber put into it. Metallic copper placed in contact with thin sheets of India rubber brings about oxidation and hardening of its substance, although no appreciable quantity of copper enters the India rubber; but metallic zinc and silver have no injurious effect on the rubber. The author had found that if oil containing a certain amount of copper, which it often does, gets on the cloth, the action of the bleaching agents on the copper damages the cloth. There is an acid in ordinary linseed oil that rots cloth. The smell of India rubber is one of the characteristics of its decomposition. When a piece of blotting-paper is placed over decaying rubber, it becomes colored by some of the emanations, as does not occur with good rubber. There is therefore no doubt that certain volatile substances are emitted during the oxidation that produces the hardening of India rubber. Rubber can be kept best under water or glycerin, or in coal-gas. It remained good when placed in a vacuum and exposed to sunlight for twelve months. All oils, except castor oil, have a detrimental effect on India rubber.

Cancer and Nervous Disease.—In an article in the Nineteenth Century, Mr. Herbert Snow shows that mortality from cancer in the United Kingdom is increasing at an accelerating rate, and that the disease is of nervous origin. According to the Registrar-General's returns, the aggregate mortality from this disease in England and Wales has grown, during the twenty-five years 1864–1888, from 8,117 to 17,506 a year. In proof that the increase in mortality can not be adequately accounted for by the growth of population, the tables are again invoked to show that the mortality from cancer per million persons living has risen during the same period from 385 to 610. The increase, year by year, has been very regular. Returns of a like character from Ireland and Scotland tell the same story. Dr. Fordyce Barker is quoted as having shown that the number of deaths per million in New York rose from 400 in 1875 to 530 in 1885. Cancer may be and often is initiated by direct mechanical injury or irritation; "but in by far the larger proportion of those varieties of cancer which furnish the bulk of the mortality statistics no such mechanical exciting cause can be detected." Moreover, as no additional liability to local injury or

irritation now exists than formerly, it is necessary to seek another cause for the increase of cancer. "When we investigate the personal history of cancerous persons, it is impossible to avoid being struck by the large number who speak of antecedent trouble, worry, or mental anxiety. In particular, the face of the average woman sufferer—care-worn, thin, and anxious—constitutes a type well known at every general hospital." The reason of the supposed connection can not be explained; "but the immediate sequence is a matter of daily familiarity, insomuch that it may be laid down as an axiom wherever the antecedents of any major cancerous growth are to be investigated, 'Failing a mechanical exciting cause, a neurotic is always to be found'; provided only that sufficient evidence of previous history and surroundings is procurable. Moreover, it is to be noted that the female, the more neurotic and emotional sex, are the principal sufferers from cancer; also that the organs in them by far the most prone to diseases of this class are normally, in health, specially and peculiarly influenced by emotional conditions, and by states of the central nervous system." The author has made some inquiry into possible hereditary transmission of cancer, but failed to find a sufficient proportion of cases of hereditary connection to justify his including that among general controlling causes.

Fine Quartz Fibers.—In a lecture on quartz fibers and their applications, Prof. C. Vernon Boys began by explaining that the physicist in making his experiments has often to deal with very small forces, which are sometimes measured by the direct pull they exert, and sometimes by the twisting effect they can produce when applied at the end of an arm acting as a lever. It is often necessary to be able to detect and measure forces not larger than the weight of a millionth or even of a thousand-millionth of a grain. If these are used to produce a twist in a wire, the wire must be exceedingly thin for the twist to be measurable. A wire when reduced to one tenth of its original thickness will only require one ten-thousandth part of the force to twist it by the same amount; and, consequently, we can measure forces as small as we please if we can only get wires thin enough. Formerly experimenters made use of metal wires, but these were soon replaced by fibers of spun glass, which can be got far finer. Glass, however, has one great drawback, in that it will not, when twisted, return to its original position after removing the twisting force, but acquires a permanent twist, and this renders it very difficult to use in delicate instruments. If we want finer wires we must turn to the single fibers obtained from the cocoons of silk-worms. These are so fine that in ordinary instruments the force required to twist them is so small as to be considered quite negligible. Some three years ago the lecturer constructed an instrument (radiomicrometer) to measure the difference in the amounts of heat radiated from different parts of the disks of the sun and moon. In this instrument it was necessary to measure a force so excessively small that even a silk fiber was too coarse. He therefore endeavored to obtain finer wires by shooting a very light arrow, which drew after it a very fine fiber of quartz from a piece of molten quartz held in the flame of an oxyhydrogen blowpipe. In this manner a thread of quartz can be obtained which is not more than one fifteen-thousandth of an inch in diameter, and which will show an appreciable twist with a force of a thousand-millionth of a grain weight applied at the end of a lever one inch long. The lecture was illustrated by a number of experiments.

Consumption Germs.—Speaking at the Sanitary Convention in Vicksburg, Miss., of December, 1889, Dr. A. Arnold Clark, of Lansing, Mich., accepted the germ as the chief source of the disease, and referred to experiments in which the germs had been found on the walls of rooms where consumptives had been; they are derived from the dried sputa of the patients. Animals, according to Dr. Cagny, feeding on the sputa die of consumption; and the disease has been produced by inoculating with the sputa, by swallowing it, and by breathing it. "When we think of the ten thousand consumptives in Michigan who every hour in the day are expectorating along our streets, and even on the floors of public buildings, post-offices, churches, hotels, railroad cars, and street cars; when we think how these

germs are being dried and carried into the air by every passing breeze, by every sweeping, and how they are capable of producing the disease six months after drying; when we think of the miscellaneous crowd sleeping in hotel bedrooms; when we think of the close, unventilated sleeping-car with hangings and curtains so well calculated to catch the germs, and where, as some one has said, the air is as dangerous as in those boxes filled with pulverized sputa where dogs are placed for experiment; then when we remember that man's lungs are a regular hot-house for the multiplication and growth of these seeds of consumption—is it any wonder that one citizen in every seven dies of this disease?" As the lesson from these facts, the author advises that no consumptive should be allowed to expectorate on the floor or street, and all sputa (from consumptives) should be disinfected and burned.

Characteristics of Leprosy.—The etiology of leprosy has been studied in Cashmere by Dr. Ernest F. Neve. The disease may be recognized in its early stages by certain integumentary changes, or by anæsthetic patches. The skin of the forehead, especially of the superciliary ridges, becomes somewhat thickened and dusky in color, but not necessarily irregular. The hair of the eyebrows is scanty. There are two main types of leprosy in the valley—the anæsthetic and the tubercular; but patients may often be seen presenting at once anæsthesia, macules, tubercles, and ulcerations of soft tissues and bone. Anæsthesia seldom remains for any length of time uncomplicated. Blisters are apt to form, and then local death of tissue and ulceration. Portions of bone removed by operation in the more advanced stages are spongy, and appear to have undergone a process of rarefying osteitis. Withdrawn nerve-influence is greatly concerned in the affection; and the nerves supplying the degraded part are found, on clinical examination, to be thickened and sometimes tender. The nerves most often involved in leprosy are, in order of frequency, the sciatic, musculo-spiral, ulnar, and median. The changes in the reflexes are essentially of the nature of diminution. Superficial reflexes disappear early. Muscular atrophy occurs in advanced cases. The tubercular form is apt to be more severe than the anæsthetic, and is often superadded. The face becomes distorted, with elevations a few lines in diameter, especially affecting the forehead, nose, and auricles, producing the characteristic leonine appearance, but scattered over the whole body. In treatment, nerve-stretching has been found valuable as a palliative.

A Sacrifice to the Yankee Pie Idol.—There is a belief, in other parts of the country, that the New England digestion has been sacrificed to pie; but few persons, probably, have known of other valuable possessions being offered up to the idol. In a biographical sketch of Charles Chauncy, second President of Harvard College, written in 1768 by his great-grandson of the same name, the writer states that, desiring to possess the papers of his illustrious ancestor, he made a search for them and found that they had descended to a son of the president, "who had kept them as a valuable treasure during his life; but upon his death, his children being all under age, they were unhappily suffered to continue in the possession of his widow, their mother. She married some time after a Northampton deacon, who principally got his living by making and selling pies. Behold now the fate of all the good president's writings of every kind! They were put to the bottom of pies, and in this way brought to utter destruction."

Mangoes.—Hundreds of varieties of the mango are grown in India; and, according to Dr. G. Bonavia, fifty or more kinds might be named which for texture and exquisiteness of flavor would more than compare with the same qualities in the nectarine and peach. Only those who have had opportunities of trying the choice varieties have any conception how good this fruit is. The uncultivated seedling mangoes are generally fibrous, but this does not prevent their having very often an exquisite flavor. To enjoy them they must be sucked. The choicest mangoes, of which there are scores, have no fiber in their pulp, and not a trace of turpentine flavor, except, perhaps, a suspicion of it in the skin. "When the skin is removed, if you shut your eyes while eating them, you might often be deluded into the

idea that you were eating nectarines, figs, etc., and sometimes a delicious compound with a dash of mushroom flavor in it. The flavors of choice mangoes are infinite, and their size varies from that of a small hen's egg to that of a good-sized melon or ostrich-egg. A choice mango can be scooped out with a spoon, and it has the texture of a stiff curd."

Cultivation of Alpine Plants.—An Alpine botanical garden for the cultivation of mountain plants has been established in Valais, under the auspices of the Association for the Protection of Plants, and was opened on the 21st of July, 1889. It includes about a hectare of land, and is situated at the height of 1,633 metres above the sea, above the village of Bourg-Saint-Pierre in the Val d'Entremont, on the Great St. Bernard road, and some three or four hours from the Hospice. The tract consists of a hill about sixty metres high, and presents the variety of soil and slope, of wet, dry, and stony tracts that promise to be best adapted to the wants of the various species that will be planted upon it. It is called the Linnæa, and has been placed under the special care of an international committee, whose headquarters will be at Geneva. M. Arthur de Claperède, of Geneva, has been chosen president of this committee; and Dr. Balley, of Bourg-Saint-Pierre, vice-president. Among its twenty-five members are Sir John Lubbock and Mr. G. J. Romanes. Visitors not members of the protecting societies of the institution will be charged fifty centimes for admission to the grounds, and perpetual tickets will be issued to those making gifts of ten francs or more.

Climatic Conditions of the Glacial Period.—According to Prof. Warren Upham's paper on the climatic conditions of the Glacial period, the formation of the great ice-sheet should be promoted by long-continued rather than an excessive cold, and an abundant supply of moisture by storms, giving plentiful precipitation of snow during more of the year than now, so as to include in the time of snow accumulation not only the present winter but also the autumn and spring months. The summers, too, were probably cooler in glacial times than now, for their heat was not sufficient to melt away the accumulated snow, which gradually increased in thickness from year to year, its lower part being changed to ice. When large portions of continents became thus ice-coated, the storms sweeping over them would be so rapidly cooled that the greater part of their snow-fall would take place upon the borders of the ice-sheet, within probably from fifty to two hundred miles from its margin; but the snow-fall during the advance of the ice was probably in excess of the amount of evaporation and melting over the whole ice-covered area. In New England and New York the average ascent of the ice was from twenty-five to thirty feet per mile for the first one hundred to two hundred miles from its boundary. Toward its center the slope diminished, as on the interior ice of Greenland; but the ice-sheet enveloping the north-eastern part of North America probably attained, as estimated by Prof. Dana, a maximum thickness of about two miles on the Laurentian highlands between the river St. Lawrence and Hudson Bay.

Cocoa.—Cocoa in its natural state contains a large proportion of fat, so that it can not be taken by persons suffering from weak digestion. The presence of so much fat prevents the easy solution of the naturally soluble portions, which are more or less locked up in the fat. This difficulty was encountered and overcome by the Indians and Mexicans in the same way as our cocoa manufacturers first overcame it—by adding to the powdered cocoa sugar and starch as diluents. Or a considerable part of the fat can be removed by pressure. Chemical analysis has shown that the estimation in which cocoa was held by the inhabitants of the countries in which it was first produced rested on scientific as well as on practical grounds. Our manufacturers are working now on the same lines as did the natives of Central America three hundred years ago, and the additions they make to cocoa are only imitations of what was done in ancient times to make its use more acceptable. As compared with tea and coffee, cocoa is deficient in those aromatic properties which have an exciting effect on the nerves of taste and smell. It has about as much of alkaloids as coffee, but

they do not exert an equal stimulating effect. It is, however, rich in such elements of a perfect food as fat, albumen, and starch, and has nearly twice as much mineral salt as tea. To obviate the unpleasant effects of the fat, a large amount of it is removed, or diluted, during the process of manufacture. When deprived of the excess of fat, cocoa yields a bland, easily digested, and slightly stimulating beverage, which is generally free from any subsequent unpleasant effects.

New Tests for Color-blindness. — The method of testing the eyes of railway servants by skeins of differently colored wools has been pronounced by the Congress of the Society of Drivers and Firemen unpractical, because the conditions under which it is made are different from any to which the men are subjected in their work. The congress has recommended that the men be tried day and night on the railway with actual signals at any necessary distances; and have suggested that, in any case in which a member of the society is discharged or reduced on account of failure in responding to the dot and wool test, he should be examined by a surgeon, with the right to have a practical trial with signals if the surgeon's report is not unfavorable. The Lancet suggests that there are other cases where a surgeon's examination may be in place—when, for instance, a man's eyesight fails after he has been on duty sixteen, eighteen, or twenty-three hours. Again, a man may have impaired his vision by excessive smoking.

Choice Oriental Fruits.—It has been said that more than a hundred different preserves could be made from a judicious blending of the fruits of the East and West Indies and of South America. The Indian preserves were formerly in much request. In the thirteenth century the most renowned preserve was a paste made of candied ginger. In India preserves and jellies are made of the pear, quince, mango, tamarind, date, guava, banana, etc. In Singapore pineapples are preserved whole, and the same manufacture is carried on on a large scale in the Bahamas. Among other fruits preserved in their natural state, in sirup crystallized with sugar, or made into jelly, are the pineapple, bread-fruit, ginger, jack-fruit, papaw, mangosteen, pomeloe, and nutmeg. Preparations of pineapple are among the best of these. Both the red and white guava make excellent sweetmeat paste or jelly. Bread-fruit, whether in sirup or crystallized, is flavorless to the European taste, and more a food-substance than a fruit. Preserved ginger is popular in England, but is not much esteemed on the Continent. The Spaniards eat raw ginger in the morning to give themselves an appetite; and it is used at table, fresh or candied. Among sailors it is considered anti-scorbutic. The mangosteen is one of the most delicious and famous fruits of the Indian Archipelago, and has the "delicate and characteristic flavor of the strawberry, grape, pineapple, and peach, combined." The mango is the best fruit of India, and is cultivated in about as many varieties as the apple. The half-ripe fruits are made into tarts and marmalades. The finest varieties seem to thrive in Jamaica, where the mango is a popular fruit with the negroes. The list of Oriental fruits available for preserves is long and contains many names hardly known, except as matters of curiosity, in the West.

Fishing for Crocodiles.—The Sundyaks, or Dusuns, of the east coast of Borneo, eat crocodiles, and fish for them. According to Mr. R. T. Pritchett's description of their mode of fishing, they bind a dead monkey as bait upon a stick, along which, at intervals, are tied lengths of fishing-twine. These are brought together some seven or eight feet off, and attached to the end of a rattan seventy or eighty feet in length. The bait is thrown into the river at a suitable spot, and the other end of the rattan is slightly secured to an overhanging branch. The crocodile takes the bait, and retires to enjoy and digest his meal, paying no attention to the stick. The hunter, going to the river the next morning, and missing his rattan, looks along the river till he finds it floating on the stream; the crocodile is of course at the baited stick. The hunter takes the rattan and with a sharp jerk upon it draws the stick "athwart-ship" in the interior of the crocodile. The rattan is pulled on shore as quickly as possible, and, with the help of as many of the hunter's friends as may be required, the crocodile is disposed of. The professional sportsmen,

it is said, address their captive, when they first get him on the line, with different titles of honor, after the manner of the ancient Egyptians, believing that the reptiles have grades and ranks, and gradually going down the scale till he is landed, when they call him very hard names.

Gutenberg and the Art of Printing.—The credit of the invention of printing in Europe appears to have been settled upon Gutenberg by the publication of a letter written by Guillaume Fichet, in 1470, only two years after Gutenberg's death, to Robert Gaguin, which has recently been found in the unique copy of the Liber Orthographiæ of Gaspar Barzilius, the second book printed in Paris, in the library of Basle. In this letter Fichet says, "They report that not far from the city of Mentz there was a certain Jew surnamed *Bone-montanus* (Good-mountain, Gutenberg), who first thought out the art of printing." The writer then dilates upon Gutenberg's superiority, in virtue of his invention, to the ancient gods and goddesses, benefactors of humanity, and concludes, "Nor will I be silent concerning those who already surpass their master, among whom Udalricus, Michael, and Martinus are said to be chief." The invention may have been original or not with Gutenberg, but this was not the first of it. The art of printing with movable types was known to the Coreans before it was practiced in Europe. The British Museum possesses several Corean books so printed, which, in the opinion of experts, are of earlier date than the middle of the fifteenth century. The same people afterward fell back into block printing.

Modes of Hoarding.—The passion for hoarding is an old one, and is naturally developed. All people love what is bright, like gold and jewels, and when it is not safe to use treasure openly, will hide it. The attribute of value, soon acquired by such objects, increases the desire to possess and keep them. The Indians, not having much stock of precious metals, laid up wampum-belts. The Celts and Goths rolled gold into spiral finger-rings, or made necklets, armlets, and bracelets of it to wear. The ancient Egyptians had their ring-money, and treasure-houses where it was kept. The Greeks deposited their money in temples, buried it in the ground, or laid it away in tombs. Many people simply bury it; and this custom is illustrated in the fairy and mythological tales of buried treasure. Hoarding seems to have been more extensively practiced in India than in any other country. It was stimulated there by the rapacity of all governments previous to the English. The efforts of the English to change the habits of the people, by establishing banks and facilities for circulating money with guarantees of security, have had only partial success. The Royal Commission on bimetallism estimates that the hoards of the last fifty years in that country represent about three hundred millions sterling of gold and silver, or nearly one third of the total value of the coin in circulation in the world. The hoards of past centuries must be added to these to get the full amount. The metal is laid up in the form of bullion or coin, ornaments, or jewelry, and it would be hard to say which form is preferred. Jewelry is prized highly, and always finds ready sale. British sovereigns are in favor, because of the image of St. George and the Dragon upon them, which appeals to religious motives. The hoards of some of the native princes are enormous. The treasure of the Maharajah of Burdwan occupied half a dozen or more large rooms and vaults. These hoards acquire in time a sort of sanctity as a family treasure, and it becomes a point of honor not to break into them; so that they are not drawn upon except in extreme cases. Hoarding is common among the thrifty peasantry of Europe; and it was by wisely using the opportunity to draw from stores thus accumulated that the French people achieved their wonderful success in paying off the war indemnity which the Germans levied upon them.

Chinese Prize Essays.—The Chinese Polytechnic Institute and Reading Rooms, Shanghai, has for several years been managing a scheme of prize essays which has expanded into considerable proportions. It is based upon the popular system of writing essays in an elevated style of composition, in which the Chinese excel to an extraordinary degree. A high official is asked to give out a subject, on which prize essays are invited, and to co-operate in the examination of the

essays and the awarding of the prizes. The subjects are given out quarterly. Three highest prizes and ten smaller ones are awarded; the essays are printed in the native newspapers, and the year's essays receiving the highest prizes, with the criticisms on them, are published in a book. For the essays of 1889, three extra subjects were selected by Li Hung Chang, far beyond the range of the ordinary Chinese scholar. They were a sketch of Western science, including notices of Aristotle, Bacon, Darwin, and Spencer; the breach of international law by one country turning its back on its treaty with another, and refusing to allow the people of the other country to come and go within its boundaries; and the suggestion of a remedy for the damaging competition of Indian tea with Chinese. There were students, however, who did not shrink from undertaking them, and "many English Sinologues were greatly bored by their native friends" for information respecting the Western *savants* and their scientific teachings, "hardly knowing, perhaps, why an interest in such celebrated characters should have been so suddenly developed among the Chinese."

A Whirligig Spider.—The habit of some geometric spiders of gyrating under certain circumstances is known, and even not uncommon, but, according to correspondents of Nature, has not been described in scientific works. A *Pholcus*, abundant in La Plata, is described by Mr. W. H. Hudson as having the habit strongly marked. It has legs of extraordinary length, and the color and general appearance of a crane-fly, but is double its size. When approached or disturbed, it gathers its feet in the center of its web, "and swings itself round and round with the rapidity of a whirligig, so that it appears like a very slight mist on the web, and offers no point for an enemy to strike at. Here the correspondence between structure and habit is nearly perfect; the slimness and great length of the legs causing the creature, at the moment the swift revolutions begin, to seem to disappear from sight; and, owing to the string-like form of the legs, the fatigue experienced is probably very much less than the action would cause in a stout, short-legged spider like the English species. At all events, it can revolve for fifteen or twenty seconds at a stretch; and, if the cause of alarm continues, it will perform the action no less than three times before quitting the web. The English spider exhausts itself in a few seconds."

Impediments to Growth of Population.—In speculating upon the causes of the stationary condition of the population of France, the customs of subdividing the land and of providing dowries for girls have been cited as important factors in keeping down the increase. Abnormal mortality from small-pox and from typhoid fever is mentioned in the Lancet as another probable cause. Dr. Brouardel has pointed out that, while Germany loses only 110 persons a year from small-pox, France loses 14,000, and that the deaths by typhoid fever amount to 40,000. These facts carry the matter back to slackness in enforcing vaccination and to faults in water-supply. Dr. Brouardel concludes his paper on this subject by affirming that if vaccination and revaccination were made obligatory in France, and if the towns were everywhere supplied with pure water, the country would save from 25,000 to 30,000 lives annually, and these, for the most part, of young persons of marriageable age.

Curiosities of Marriage.—The theory of English scholars concerning the evolution of marriage is in a measure confirmed by Prof. Kovalevsky's studies in Russian ethnography. The evidence of a primitive condition of great license is, however, slight, and rests principally on the testimony of prejudiced witnesses. The evidence of a matriarchal and endogamic stage is stronger, and receives some confirmation from customs that survive among Russian peasants. The transition to marriage by capture and exogamy was general. The former practice existed in Servia and Montenegro until recent times. The growth and prevalence of the custom of purchase are shown by the wedding songs in use among Russian peasants. The Mordvins of Russia, according to the Hon. John Abercromby's conclusions, before they came in contact with the Slavs, wooed by proxy and contracted marriage by purchase, but went through the form of

capturing and carrying off the bride as a proof of courage and address. The author calls this form marriage with capture instead of marriage by capture. He thinks the latter was not in use among them, while marriage by purchase may have existed among them from the polished stone age. Capture is sometimes resorted to to reduce the price of a girl or to avoid payment, but is an incident of marriage by purchase. Among the Manchus, according to a gentleman of that people, the middle-man takes a large part in arranging marriages. When he has brought the parents of the pair to an agreement, a solemn inspection of each party is made by the mother of the other, to see that the bridegroom is not dumb, the bride not lame, etc. Then cards and presents are exchanged. The marriage ceremony lasts three days. In the bridal chamber the couple are fed with "offspring dumpling" and "longevity dough"; and a "longevity lamp" is kept burning. An important ceremony is the uniting the cups, by the couple drinking wine alternately from two cups tied together by a red string. Frequently children are promised to each other in marriage while still very young.

Gypsy-carried Folk Lore.—"Gypsies," says Mr. Charles B. Leland, "have been the colporteurs of witchcraft." A hundred confirmations, the Athenæum observes, "might be adduced of the saying. It is fifty years now since old Mrs. Petulingro traveled Norfolk with her sparrow that told her all manner of secrets; to-day her descendants are camping in Scotland, Ireland, America, and New Zealand. Wherever they have wandered they have carried with them both gypsy and East-Anglian superstitions; so that you still find them counseling a Clydesdale beekeeper, who has just lost his wife, to 'tell' the bees and put crape upon his hives, practicing their own strange methods of ordeal and *tabu*, or plucking out the heart from a live white pigeon at midnight and casting it on a clear fire, as a gypsy girl did five years since, to put a spell upon her false lover. For gypsies both borrow and lend: if they gull, they are gullible, and the gentile 'wise man' has no more credulous victims. Found as they were in Finland in 1580, in Shetland in 1612, and roaming as they do from Poland to China, from Hungary to Algeria, the gypsies are a most disturbing factor in the problems of folk lore. How much they have done toward the diffusion of magic and folk tales it were hard to estimate; that they may have done very much is at least possible. Their tales present all the familiar features (of swan-maidens, forbidden chambers, the grateful dead, etc.); their superstitions in eastern Europe are often identical with those of our English peasantry—e. g., Transylvanian gypsies seek out a drowned body with a loaf having quicksilver in it. And only last summer a member of the Gypsy Lore Society discovered in Argyleshire a band of boat-dwelling 'tinklers' speaking good Romany."

Phenomena of Stream Currents.—In a paper on the flow and friction of water in open channels, read by Dr. D. T. Smith at the American Association, the questions were asked: Why are there streams? Why are the channels of streams trough-shaped? Why are streams higher in the middle than at the edges? Why is the greatest speed of streams not at the surface but at some distance beneath? Why do streams flowing into the sea through deltas have plural mouths? Why are the banks of rivers in deltas raised above the adjacent lands? Why do rivers, flowing down steep inclines, early come to an even rate of speed, and not increase in speed to the bottom of the incline as do solid bodies in falling? Why does drift move from the margins to the middle of rapid streams? Why are rivers deep just before entering the sea, yet entering with the bottom sloping upward? These phenomena, it was claimed, are all produced by movements in the water due to unequal friction. The particles of water rubbing against the sides of the channel are retarded more than those next within, and, as those outside fall behind, those next within move out and take their places, thus preserving the width of the stream. Those next within take the place of these, and so on to the middle of the stream at the bottom. As the water at the bottom moves out, that above settles down in the middle. As the water moves against the banks, it is raised up by the force with which it strikes, and the surface of the stream at this stage

potentially represents a trough. The water from the edges of this trough flows back obliquely toward the middle, and by the time it reaches the middle it gains such momentum that the middle of the stream is made the highest. Every stream is by these forces resolved into two cylinders, revolving spirally on parallel axes in opposite directions—that is, outward at the bottom, upward at the edges, inward at the top, and downward through the middle. The principle is denominated "the law of the double spiral," and affords an explanation of all the phenomena in question. Since glaciers are subject to the same conditions, it is believed that they are subject to the same movements. It is believed to apply to air currents also, and that the Western blizzard and the Texas norther may be in part due to waves of cold air descending to take the place of that which friction has caused to ascend the Rocky Mountains.

Diffusion of Jade.—Inferences that extensive intercourse between distant regions prevailed in prehistoric times have been drawn from the general dispersion of jade ornaments in the monuments all over the world, and the paucity of known sources of the mineral. Many possible sources of jade have, however, been discovered within a few years, in view of which the necessity of men anywhere having to go to the ends of the earth for their treasure becomes less apparent. Mr. F. W. Rudler recently mentioned to the Anthropological Institute, as among the later discoveries of jade *in situ*, those of Herr Taube, of Breslau, at Jordans Mühe in Silesia, and at Reichenstein; the rough pebbles that have been found in the valleys of the Sann and the Mur in Styria; Dr. Dawson's account of the occurrence of bowlders partly sawn through on the Fraser River; and the discovery by Lieutenant Stoney of the mineral *in situ* at the Jade Mountains, north of the Konak River, in Alaska.

Medicine in Thibet.—The course of instruction at the Thibetan University of the Guinoie Ozero Monastery is very elaborate and is adjusted for ten years of studentship. It includes the Thibetan and Mongolian languages, religion, drawing, handicrafts, astronomy, astrology, philosophy, and theology. The medical course requires three years. The Thibetan medical authorities, according to the Russian M. Ptitsyn, recognize 101 fundamental diseases; and 429 names of elements of drugs used by them are given. Of the 101 diseases, only two (paralysis and a kind of influence of the planets) are attributed to a mythical origin; and of the 429 drugs, only three (the bones of a dragon, the horns and the skin of the unicorn) have a similar derivation. The remainder of the drugs are chiefly herbs, seeds, fruits, roots, and flowers, and partly mineral matters. All, except quinine, which is bought in Russia, are obtained in Chinese drug-shops. M. Ptitsyn visited one of the drug-shops, and found all drugs kept in order in separate drawers. He has brought samples of 202 drugs to St. Petersburg, and they will be analyzed by the Medical Academy.

NOTES.

THE fourth season of the Marine Biological Laboratory at Wood's Holl, Mass., Dr. C. O. Whitman, director, will open for teachers and students, with courses of seven weeks' instruction in zoölogy, botany, and microscopical technique, July 8th. The first week will be devoted to the study of the lobster, the second to annelids, the third to cœlenterates, the fourth to mollusks, the fifth to echinoderms, the sixth to crustaceans, and the seventh to vertebrates (marine). The laboratory for investigators will be open from June 1st to August 20th, furnished with aquaria, glassware, reagents, etc., but not with microscopes and microtomes.

M. DE QUATREFAGES lately reported to the French Academy of Science the discovery, by M. Wanzel, of the skull of a cave bear bearing the marks of a wound that had been received from a stone hatchet. The wound had healed, with the formation of a callus. Two pieces of the hatchet had been broken off by the blow, one of which was left in the wound and had been covered by the callus.

THE Pope has written a letter announcing the re-establishment of the donation for the astronomical observatory at the Vatican. He declares that he is solicitous for the progress of science, and places the observatory in the same rank with other papal institutions.

THE seventieth birthday of Prof. Helmholtz will occur in August next, and, in anticipation of the event, Profs. Virchow and Du

Bois-Reymond have been constituted a committee to arrange for a suitable celebration of it. A like anniversary will come to Prof. Virchow on the 13th of October, in view of which English and German co-operating committees have been formed. The English committee includes Sir James Paget, Dr. Lauder Brunton, and Dr. Victor Horsley. A medal, bearing Prof. Virchow's likeness, is to be struck, and the rest of the subscriptions are to be given to him personally.

THE French Academy of Sciences gave its Lalande prize for last year to Prof. Schiaparelli, of Milan, for his discoveries concerning the rotations of Venus and Mercury; and the Janssen prize to Prof. Young, of Princeton, for his spectroscopic discoveries, especially of the infra-chromospheric layer of the sun which is called by his name.

THE fiftieth anniversary of Prof. Arcangelo Scacchi's professorship of Mineralogy in the University of Naples was festally celebrated on the 8th of February. Most of the scientific institutions of Italy and some of other nations were represented, the Geological Society of London and the Mineralogical Society of Great Britain by Dr. Johnston-Lavis. A gold medal, bearing his head and a suitable inscription, was presented to Prof. Scacchi; and a memorial pamphlet containing, with other matters, a biography and a list of his works. He having resigned his professorship, his son, Prof. Eugenio Scacchi, will take his place.

CAPTAIN W. DE W. ABNEY has expressed the opinion that the action of light on fugitive dyes must eventually teach us something as to the character of molecules, and add to the methods by which their coarseness may be ascertained.

THE mischievous prevalence of locusts in Cyprus is ascribed by Sir Robert Biddulph to the destruction of the forests. By the resultant washing away of the soil the ground became barren, and the locusts at once took possession of it. It is only since the forests were destroyed that this pest has made headway in the manner which has been so notable in modern times. Its great breeding ground is not likely to be ever again covered with forest, and its disappearance will depend on the increase of population and cultivation.

THE New York State Engineer has reported to the Niagara Falls Commission that the Horseshoe Fall has receded an average of 104 feet 6 inches since 1742, but at one point 240 feet, while the American Fall has receded 30 feet 6 inches. The crest of the fall has increased in length, from the washing away of the embankment, from 2,260 to 3,010 feet. The area of recession of the American Fall is 32,900 square feet, and that of the Horseshoe Fall 275,400 feet.

FROM the examination of the paper of Dr. Purdy, of Chicago, and other sources of evidence, the Lancet infers that the most important causes of Bright's disease are improper food, unwholesome occupations, and insanitary dwellings; and from the study of the question it is led to the same conclusion as from the study of phthisis, that "the chief danger of humanity at the present day is that the growth of great cities may lead to the neglect of some of those primitive conditions of health—fresh air, light, exercise, plain food, healthy housing—without which the vigor of the organism can not be long maintained."

CERTAIN resemblances which are sometimes observed between man and wife have been ascribed to the influences which the parties exert upon each other, with increasing effect as they live longer together. Mr. Hermann Fol is of the opinion, however, that more or less striking likenesses often exist from the beginning, and form one of the attractions that bring the parties together. In the photographs of 251 couples, not personally known to him, he noticed resemblances in more than two thirds—in 66·66 per cent of young, and 71·70 per cent of old couples.

MR. NEVILL, Superintendent of the Natal Observatory, South Africa, remarks that the number of thunder-storms has been gradually decreasing in all the larger towns of Natal, but most markedly so in Durban and Maritzburg.

DR. OLIVER, of London, is engaged in an investigation, from a botanical point of view, of the effect of fog upon plants. The examination of specimens of plants affected by fog is in the hands of Prof. D. H. Scott, of the Royal College of Science, South Kensington.

A PROCESS for preserving dead bodies by galvanoplasty is described by M. Variot in La Nature. To facilitate the adherence of the metallic deposit, the skin is painted with concentrated solution of nitrate of silver. This is reduced with vapors of white phosphorus dissolved in sulphide of carbon. The body is then treated in the electric bath. The metallic mummy is then incinerated, and after the corpse has disappeared—the gases escaping through openings provided for them—a faithful image or statue remains.

MAINTAINING that short-sightedness, or myopia, is a product of civilization, M. Motais, of Algiers, cites his ophthalmoscopic experiments with the eyes of tigers, lions, and other wild beasts. Those which are captured after they are six or eight months old are and remain hypermetropic, while those that are captured earlier, or are born in captivity, are myopic.

THE Pamban-arivy, or Snake Fall, of Trevancore, India, is a double fall, descending in the first plunge from the cliff edge twelve hundred feet, and can be seen from a distance of forty miles.

OBITUARY NOTES.

HERR KARL WEIHRAUCH, Director of the Meteorological Observatory in Dorpat, Russia, has recently died, at the age of fifty years.

THE death was announced, early in the year, of M. Clevaud, Professor of Botany at Bordeaux, and author of the Flora de Gironde, a work of which two parts have appeared, and which "is characterized by its beautiful plates, and by the attempts to place on a scientific basis the genetic relationship of the various species with one another."

PROF. SOPHIE KOVALEVSKY, of the University of Stockholm, who died February 10th, was a woman of rare mathematical gifts. Besides an autobiographical sketch, which is described as "one of the finest productions of modern Russian literature," and a fragment of a longer novel, she wrote several able papers in the higher mathematics. She has recorded in her Reminiscences a curious experience of her childhood. In repairing her father's house in the country (Russia), the wall-paper for the nursery was overlooked in ordering from St. Petersburg. For want of anything else, the room was papered with a set of Ostrogradski's lithographed course on higher mathematical analysis. The ten-years-old girl acquired the habit of reading the learned dissertations, and became so familiar with their language that when she began, at sixteen, the study of the differential calculus, her teacher was astonished at the rapidity with which she understood him—"just as if it was a reminiscence of something that you knew before," he said.

MR. GEORGE WAREING ORMEROD, of Teignmouth, England, a student of local geology, and author of papers on the salt-beds of Cheshire and the granite of Dartmoor, died in January, eighty years old. He had been a member of the Geological Society of London for fifty-eight years, and continued the compilation of the classified index to its publications, which he began early, till he had reached an advanced age.

ANTONIO STOPPANI, an Italian geologist, died January 1st, at Milan. He conducted a scientific periodical, Il Rosmini, which was in sympathy with the teachings of the philosopher of that name. Of his books, one called Il Bel Paese, or The Beautiful Country, has been published in several editions.

DR. FELIX LIEBRICHT, who died in August last, in his sixtieth year, was an early and successful student of folk lore and comparative mythology. He was a native of Silesia, and spent the greater part of his working life as a professor in the University of Liége. He translated Basile's Pentamerone from the Italian, published a version of the romance of Barlaam and Josaphat, brought out an annotated edition of Gervase of Tilbury's treatise—a sort of encyclopædia of mediæval folk lore—and in 1876 published, under the title of Zur Volkskunde, a selection of his contributions on his special subject to periodical literature.

CHARLES JOHN MAXIMOVICZ, the famous Russian botanist, one of the most distinguished systematic botanists of our time, and the great authority on the plants of Eastern Asia, died in St. Petersburg, February 16th. His scientific career began with a journey in Manchuria, the botanical results of which were published in 1859. He next made large collections in Japan and distributed them among the herbaria of the world. From time to time since 1866 he published critical notes of Manchurian and Japanese plants, and was the author of monographs of the Rhododendrons, the Hydrangeas, and the Buckthorns of Eastern Asia.

GENERAL LIAGRE, of the Belgian Engineers, who died in January last, was well known in the scientific circles of his country. He was attached to the observatory as astronomical aid, and, after the death of Houzeau, as a member of the Directorial Committee. He was a distinguished mathematician.

THE death of Mr. John Marshall, President of the British General Medical Council, at the age of seventy-two years, on New Year's day, was followed by that of Mr. Edward Bellamy, Lecturer on Artistic Anatomy at the South Kensington School, January 4th.

PROF. CASEY, Fellow of the Royal University of Ireland, an eminent mathematician, died January 3d, in the seventy-first year of his age.

THE deaths have been reported of Dr. Karl Weihrauch, Director of the Meteorological Observatory of Dorpat, January 19th, in the fiftieth year of his age; M. Emile Reynier, electrician, January 20th, at the age of thirty-nine years; and Mr. Cosmo Innes Burton, Professor of Chemistry at the English Technical Institute at Shanghai, in the twenty-eighth year of his age.

DR. PHILIP CARL, Professor of Physics at the Munich Royal Military College, and editor of the Repertory of Physical Technics and the Journal of Electro-technics, died January 24th.